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**Facility Decontamination Technology Workshop
November 27-29, 1979
Hershey, Pennsylvania**

Volume II - Discussion Groups

Sponsored by
Department of Energy
and
Electric Power Research Institute

January 1982

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**Facility Decontamination Workshop
Discussion Sessions
November 29, 1979**

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REMOTE DECONTAMINATION TECHNIQUES WORKSHOP

DISCUSSION LEADER - FRANK MCDOUGALL (BECHTEL)

Remote Decontamination Techniques Workshop

Discussion Leader - Frank McDougall (Bechtel)

Is remote decon a viable option? If so, what can we do in advance to determine its use and effectiveness? The first question I'd like to pose is, "Is there a need for remote decontamination using the containment spray system or an equivalent?"

What you find on swipes and samples in terms of the chemical composition, may indicate what type of remote decon flush you're going to use or what sequence you'll use. But this will really not eliminate the use of remote decon unless you find something that is non-soluble.

I think the first step should be a study to determine where the building spray system hits. The building spray system does not hit that many areas. Oak Ridge has done a study on a sample removed from the lower level, the 290 or 300 level. By running water over it they did not see any decontamination. Decontamination by just running water down the side of the building will not work. Given the low levels you are seeing in there now, it should be possible to get in there with some remote equipment.

What is really meant by remote? In order to keep rad doses down to a reasonable level, a piece of equipment should be set up and operated from somewhere else initially. I would classify that as semi-remote, or remote. You have to have a working area started in the building.

The terminology "remote decon" right now is being connected to the containment spray system. Gross decontamination means you have to get someone inside to set up an internal spray system. That person can then leave after turning it on. I'd like to confine the discussion to the containment spray system right now. The comments on the coverage of the spray system are correct. Obviously, the spray system considering intermediate floor levels is not going to spray directly on a lot of the equipment. We are evaluating just what portions are being covered. Initially, we've found that it will touch on roughly half the equipment.

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(Question) - How well does that cover the operating deck, and the cylindrical sides of the containment above the operating deck and the dome and the polar crane?

(Answer) - Fairly well. I was involved in the Zion project and part of the licensing requirement was that we run a full blown test on the containment spray system prior to operation. It was a very messy test. We were at the operating deck in unit one (no equipment inside) and the NRC wanted to know how well we hit the walls and covered the floor (distribution test). The way we did that was to put troughs all over the operating deck and measured the water levels with different combinations of sprays. We did cover the walls and ceiling quite well but with a lot of water in the containment. In unit two we did it with just the steel shell. We used about 3500 gallons per minute. It did wash the walls down and covered well. The second time we had people inside during the test.

(Question) - What kind of pressure did it exert on the surface? Wetting the surface and having some sort of pressure on the surface are two different things.

(Answer) - If you had some soluble compound, pressure is not necessary to wash it away. If the surface has not dried out or caked up the pressure is not necessary for a soluble compound. But, there is a lot of information, not on concrete walls, but in other areas that when a soluble compound is absorbed on the surface it doesn't necessarily act like a soluble compound.

First of all, someone made the comment that "we should challenge the obvious." One of the things I think we should challenge is the idea that we can't achieve any decontamination on the basis of one test. I think that you can't make that kind of a decision on the basis of one test button [referring to plugs cut from penetrations] and one kind of surface and one type of material. You have to look at what you're trying to achieve with this. You mentioned the criteria, at least two: dose rate reduction and contamination reduction. There is, at least, a third and that is clean-up or housekeeping. Somebody mentioned that NaOH may be all over the place and there is a potential for boron crystals. The other thing is in an ALARA type cost benefit analysis. What is it going to cost to do it versus what will be achieved. Basically, the cost seems to be rather cheap exposure-wise anyway (not including radwaste), to accomplish a significant gain in reducing the surface contamination.

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I think in looking at this the criteria should be what can be gained without having to go in, get close, waste a lot of exposure and, perhaps, not really achieve much more.

In particular, the β dose will be controlling; it has been found to be controlling everywhere else. We're talking about a dose rate from the surface with a β to gamma ratio of 10:1 to 100:1 and we're talking about methods of trying to shield the people from the β 's with rubber suits, etc. Nevertheless, much of the time will be spent on the operating deck with the polar crane. The polar crane is very important. It's very difficult to decontaminate 100' above the operating floor; and we could do some preliminary decontaminate with this spray. Even if we'd get a factor of 10 and no better, it's still considerable improvement for the operating deck and everything above. For the walls, there's a terrific amount of surface area that's relatively inaccessible. You'd have to build scaffolding if you did not use the sprays.

The comment about the potential advantage of saving man rems is being evaluated also. We recognize the need for a man rem assessment for the overall recovery program with decon being a major part of that is an iterative process. You start with the first cut and as more information is gained, that information is fed in and the study is redone. The intent is to have some kind of an ongoing, best-guess as to the man rem situation so that input is available for making the final decision whether or not remote decon is used. It is, however, important to try to find out more about what is in that containment in terms of what type of contamination there is.

I think the logistics of having the present inventory of water in the containment shell is a nasty problem that you need to know about. You may find that one of the things right at the present time governing the recovery program is that every gallon of water has to be processed. The thing that's governing the recovery program is that high inventory of water.

In considering the use of water we should remember the results of the test at Oak Ridge. In the case of the lower plug cut from penetration that was analyzed, Oak Ridge sectioned that into 8 pieces. On one or two pieces we used a proposed Bechtel procedure which is outlined in the re-entry study. We found that on that particular plug for those isotopes it did not work. The upper plug cut from the penetration is a stainless steel section. That particular type material is probably not

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characteristic of the rest of the containment shell. But the overall point I'm trying to make is that we really don't have enough information to make a decision.

(Comment) - You did make the comment that the results were somewhat inconclusive due to the fact that there was probably quite a bit of heating of that plug when it was cut. The comment earlier about drawing too many conclusions from one test is one we must keep in mind. Also, the difference in the coated versus the steel surfaces is important. The wash might do some good on the steel surfaces; the refueling pool for example. Even the grating that's located in various areas might be affected.

(Discussion leader) - I'd like to hear more about what can be done at this stage, and subsequent stages as various info comes in, to help shed some more light on remote decon. It's not a minor undertaking. It requires modifications to plant systems and could very well be on the critical path of the schedule for recovery simply because of the radwaste processing. The comments about the amount of radwaste generated show it's a very real problem. It's quite possible to use recycled water in remote decon but each time it is run through the containment it has to be processed and the rate at which you can process that may add weeks and weeks to every flush. I doubt whether we'll ever get any real quantitative type of assessment on remote decon, but at least we can say it would have these advantages and we can perform other evaluations. I heard one mention about coverage of the spray system and that is being considered. Another thing that we've talked about is simulating to the extent possible the situation at TMI in a test chamber. There was some thought given to taking a smear of the operating deck, dumping a bucket of water and letting the water run over the surface, then taking another smear.

(Comment) - At the chemical plant in Idaho, where we've been decontaminating hot cells for some 25 years, we've found it's important to get the overall background level down. Every time you send a guy in there he's not only going to get a dose from what he's working on but also from the general background. Anytime you can get the overall background down, even though it will give you aggravation as far as the H₂O is concerned, it helps every person that goes in there and you'll reduce the number of people in your training loads substantially by getting that background down as low as you can reasonably and quickly.

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(Discussion leader) - One thing that I think should be mentioned is the volume we're talking about is somewhat misleading in that the idea is to work from the top down in cleaning the place up. If you had to do it by hand versus the sprays, by the time you worked your way all the way around the containment down to the operating deck itself, you're going to use maybe the same volume of water. Saying that this volume is much greater than another volume is not necessarily true. You use just as much, or more, doing it with hands-on techniques.

(Comment) - One of the things that we've failed to figure out is just how this contamination is attached to the surfaces of the building. It has been there for eight months now and will be there for another 6-7 before something is done about it. We're normally talking, in decon, about spilling something and going in and wiping it off. This contamination could undergo some sort of ion exchange with the painted surfaces and spraying with water won't do any good. A DF of one and two isn't going to do any good considering the problems involved in spraying large amounts of water in the container. Someone will have to go in there and scrape some paint off the liner to find how that contamination is bonded to the surface.

(Discussion leader) - That's a very good point. We did have some paint [on one of the test plugs] and once you get beyond that paint on one of these sections, you see no activity. One point that I failed to bring out is that the activity on the lower plug is different than on the stainless steel. The activity on the lower section looks like the volatile fission products. Also looking at that steel plug you see a series of streaks. It looks like the spray was not uniform on that surface. That plug was probably not sprayed directly.

The way the original paint system was qualified for decontaminability was based on a method that is quite different from the contaminants that you see here. Decontamination procedure can't be established until you have some surfaces to work with. I'm not sure it is necessary to make an entry to get those, however. If you come out with scrapings, you still may not know what you need. What you need is a surface that has been coated with a coating that is similar to what's in there that's been immersed in something that we can take out to a lab and build a model, chemically, of potential decontamination techniques and repeat with some accuracy until we can come up with a remote decontamination procedure. At that point, we could weigh that in terms of

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whether its effectiveness and cost. Until we get those surfaces to work with, everything is speculation.

The auxiliary building has concrete surfaces that have been coated with the identical paint as in the containment. Much of the contamination there is similar to that in the containment. There could be preferential plate out of certain isotopes. There probably was some dilution by the time it got into the auxiliary building, but we could use the auxiliary building data.

There is some information available from the auxiliary building already. When they went in to decon those floors, after one or two passes and they were down to the very low levels but the activity leached out. After so many passes with floor scrubbers floor samples were taken in July or August and sent out for analysis. The analysis of painted and unpainted surfaces showed activity only on painted surfaces. Unpainted surfaces that were flooded showed no activity leached out. This was on the 305 level where a tank overflowed. There was no activity on the unpainted surfaces.

Activity in the painted surface was Cs 137. This stuff just did not come off with simple wiping. They went through a number of times and scrubbed the heck out of the floors. That's the same type coating that is in the containment building.

(Comment) - Evidence is that it's the same coating. After three passes in the valve room in decon, we did remove coating chips and sent them in for analysis and found 300 microCuries/sq. ft. activity levels in the coating. So, it is imbedded. To determine the feasibility of remote decon, surfaces that have been exposed must be worked with until you can come back and say, "Here's a DF of 20 using this particular chemical solution." Then you can decide if you want to spray or not. You can be sure, from the data we've seen now that spray water won't do any good. I think we can conclude that.

(Several voices state disagreement.)

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(Question) - Where do you expect to make entry?

(Answer) - The airlocks are on the intermediate levels. You've got 7" of concrete on the floor below you where you're walking in through the airlock and if you've removed the water from the sump the question then is, "How much residual radioactivity will remain and shine through 7" of concrete, that, we think, is still going to be controlling?" We're talking about approximately 120/hr. gamma from the water in the sump. If we pump that water out, we figure you'll get it down to 10r./hr. perhaps. You may get more. The 7" of concrete will give us approximately a factor of 10. So we're going to drop from almost 10r./hr. on the intermediate elevation down to 1r./hr. We think the plate out in that area will probably not be more than that so that it will be on the order of an r. per hour.

There is thought of putting in 2-3 ft. depth of demineralized H₂O in the sump to shield out at least the floor. It won't shield the walls because we're up to about 7' on the walls.

(Comment) - When a man makes entry into the containment he should be able to tell pretty easily whether or not you've got a smearable contamination. If he takes a paper towel and reaches down and makes a swipe and puts it up against the cutie pie and reads an r. You've got something there that can be washed off. That's not very scientific but it might work. If that thing shows a hot smear, the man should get in there with some kind of a spray nozzle. I've seen some with a jet pack that can take the paint right off the walls. When you're talking about a decontamination factor of 20, you're talking about scraping off 95% of activity. If you can get 95% of activity by one man walking in and spraying the whole room in a matter of 3-5 minutes, that is a lot better than going in with a scrub brush.

(Comment) - I agree you can take the smear off with the hydrolaser, however, that doesn't necessarily mean you'll get it off with the building spray system.

(Comment) - I wouldn't use the building spray system. I'm talking about making sure you've got contact with what you're spraying. The BSS just running down the walls is just wasting time.

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(Comment) - Another thing that's misleading here is talking about getting paint samples to determine whether or not contamination is going to be imbedded in the paint and so forth. You have to look at what you're hoping to achieve by using the BSS and, generally, I don't think that's decontamination of the painted surfaces. You have to look at the ratio of painted to unpainted surfaces.

That isn't the point. We need to know the properties of the coating surface with as much detail as we possibly can. We can't know too much about that epoxy surface. We could open that thing up like a book, then, and know exactly what it responds to and know what water and steam will do to it.

(Discussion leader) - One of the factors we haven't addressed here is that if we in fact go in and get a sample and find out what it would take to get this paint off, whatever that solution may be cannot be thrown about the containment in an uncontrolled manner because the material compatibility of the solutions with all the safety-related components in there. It might be that we're going to end up with a decision that says one deionized flush with the containment spray system then we go in and find out what's going on. Then we remote decontaminate in a more controlled sense. We just can't spray some of these exotic chemicals into the containment because the next question is, "How do you process it?" Once it gets down into the sump, how do you remove the activity and get rid of this stuff?

(Comment) - One thing to be considered is to, perhaps, build a little shielded enclosure right inside the containment, inside the airlock and do some experiments right there immediately. Build up a little shield with lead on the floor and work on selected areas.

Discussion at this point turned briefly to radwaste problems. General consensus reached was not to limit decontamination options by providing insufficient processing capabilities.

(Discussion leader) - One of the big problems in remote decontamination is the quantity of water involved.

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(Question) - What if you just assumed you could recycle the sump water?

(Answer) - That is a problem. There is tritium in practically a million gallons of water.

(Comment) - Your tritium problem will go with the original waste. Once that waste is worked off—you're not generating any more tritium.

(Discussion leader) - But, you can't recycle that water. You have a health-physics problem in terms of recycling. The idea was to avoid generating any more water than we had to and to use this sump water, after recycling, for the sprays. So it would contain tritium. If we recycle that same water for the sprays, we'll have the tritium as long as we're using the recycled water. We would like to make sure the final spray is with demineralized water to remove the rest of the tritiated water before we send any people in because of the health-physics problem.

(Discussion leader) - I think we're getting a little too much into the radwaste problem. I think the point is well made and I don't think we've lost track of it. The trouble in defining the radwaste problem is that there isn't enough input from the decontamination part. That's why the decontamination effort has to be in the forefront.

(Comment) - Shouldn't the decision-making sequence run something like this:

1. How is the surface going to behave?
2. What chemicals will do what things to that surface?

After determining an acceptable method, then you decide how to get that chemical in and out.

(Discussion leader) - The thinking process has not been that way—it has been to see what can be done with water. If the job can't be done with water, maybe we'll include some radiac wash. Let's stay away from chemicals unless we know the job can't be done with water.

(Comment) - Would it be more logical to be thinking about some kind of a chemical wash that might be much more effective per gallons in the containment? Maybe

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in the long run that's going to be less radwaste generated for the effectiveness of the decontamination.

(Comment) - It might be a terrible mistake to settle on water. It seems that right now the book ought to be wide open. You can look at anything. You can then come back if water is the only thing that could be used.

(Discussion leader) - When you start looking at chemicals, you're looking at a whole qualification program for RCS and all the materials and safety related equipment in the RCS. This would not be done, then, tomorrow or six months hence but 2-3 years from now if you want to make sure you have an intact RCS when you're through. We might not have that kind of time.

That's only one element in the decision. Man rems, cost are all factors in the decision. You can do all kinds of chemical tests by taking samples out of the building (if you can get samples out) and find that certain chemicals are good or bad for removing it but then you have to take that particular chemicals and do materials tests on everything. That's going to take years and years to assure yourself that you won't affect the RCS. The smaller pieces of equipment in there may never be recovered for use again. You almost have to put yourself in a throw-away mode for about 95% of the smaller equipment. You don't have to worry about how you beat them up getting them out of there because you'll have to replace them anyway.

One thing I'd like to get back to is the ALARA aspects of this and not get confused with a "final decon" which may be some drastic chemical. An initial water spray may do a lot of good as far as reducing the β problem that you have and helping you out ALARA wise. If the β contaminants are not fixed in the paint, you may help yourself considerably by doing a water washdown to get rid of the β problem and then go after the heavier stuff. Move from simple to complex. Start out with little exposure and gain what you can as you go. Look at it as an overall exposure reduction effort rather than an overall decon effort. The two may not necessarily correspond.

Studies of the plugs that have been taken out of the auxiliary building showed that the radioactivity, independent of whether it was Cs 137 or strontium 90, penetrated the coating as far as the sealer on the surface of the concrete. It did not penetrate the concrete itself.

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(Comment) - It seems as though one consideration would be to start processing the sump right now at some low rate and getting as pure water as possible in that sump to permit, perhaps, some future pure H₂O decon. Another consideration might be to spray 1500 gpm with filtration and demineralization only and letting that spray system run for several weeks. If that can do it for you, it would be a lot easier than going in there with shields and masks, etc. Is consideration being given to something like remote fire hose extension ladders with a hose at the end that we could put in the entrance and move around the containment and do a localized spray.

(Discussion leader) - We've given that some consideration. That may have to be done anyway - even if we use remote decon.

At this point I'd like to propose that we assume we will use remote decon and consider other questions associated with its use. The Bechtel study reports using large volumes of water (250,000 gal. at a time) and people think of these large amounts when they think of remote decon. Would it be worthwhile to try small amounts? Is it worth spraying 50,000 gal. into the containment and then get some kind of measurement? Could we talk about the amounts of water and get some ideas on this?

(Comment) - I think that it has to be recognized that some fraction of the original water in containment is going to stay there. So finding out whether this trial spray is going to be effective or not will be difficult because you'll be picking up activity from residual water. Nooks and crannies that don't drain well may hold as much as 5-10% of the original water. The measurement method that is used on a trial basis will have to overcome this or take it into account.

(Comment) - There might be a way to go about it. As the estimate of inventory of isotopes in the containment is getting a little finer, perhaps we could key on an isotope and do a Curie balance and maybe get an answer in that way. Also there may be spots in the basement that won't drain well, then if you spray another 10-50,000 gallons in there, it might dilute those spots.

I think if you measure the effectiveness of the decon, you don't want to look at how many curies you've washed off the wall. The main purpose of the decon is to reduce dose rates. We'd want to set up standardized survey locations for both smear

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and dose rates and have that as a pattern which you can go back and take repeated measurements in exact locations each time and see how much good you've done. For instance, you may wash out 50 curies but if you haven't changed the local working area dose rate, you haven't helped yourself any.

We heard about ALARA considerations for steam generator replacement. In doing the man rem estimate for that it was necessary to look at each individual work function to be performed in the entire job and estimate that. I think your ALARA considerations, man rem estimates and subsequent accumulated dose is a major consideration. After all, the only reason you decon is so that people can have access. The steam generator removal was tied to a specific man rem budget. That was the primary consideration throughout the whole job.

(Question) - In what way were they tied? Had they estimated a certain amount of man rems/job and that then became the budget?

(Answer) - That's right.

(Discussion leader) - We have determined over 100 specific tasks that must be done on TMI. We have determined for four different cases the man rem required to perform these. The first case was containment purge with the sump drained and with remote decon before any hands on decon is attempted. Second, containment purged and sump pumped but without remote decon. Third, with just purge of containment without complete pumping of water from the sump. The fourth case was the case of trying to go in without even purge of the containment. These numbers are not final as yet because of uncertainties in the β to gamma ratio. For example, we've heard that the β to gamma dose rate ratios are as much as 100:1 or so. For instance, at SL-1, the actual dose absorbed by people was 4 or 5:1, so that we're looking at this to try to shield out the β and waiting to get a smear from the operating deck to determine the β to gamma ratio. At that time, we'll finalize these calculations. The only credit we're taking here for remote decon would be a maximum of a factor of 5 on the operating deck and above. Why "5"? Why not a larger number? Because we've got a lot of sources on the operating deck. Sweep down and wash with water as much as you want but that concrete block stairwell is just not going to be decon. Because it hasn't been painted and it's just going to soak up the radioactivity in the water--it's going to have to be removed. That's the

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only way to get rid of that. Also, there are containment air coolers there that have circulated this atmosphere and are probably highly contaminated. We're looking at, perhaps, a reduction factor of 5 for the operating deck and no reduction factor for the intermed. elevation with remote decon. We think that, perhaps, the remote decon might have as much as a factor of 2 on the lowest level only because what it does after you pump water out of the lower level—you're going from 120r/hr down to 10-20r/hr range. The remote decon water might wash the walls to some extent and wash the basement floor to some extent and clear out a little bit more residual radioactivity in the sump. That makes a difference of about a factor of 3 in the whole body and the β man rem estimates.

(Question) - Wasn't your man rem study [referring to steam generator removal] based on the actual physical in-place study with somebody going in and finding what the dose fields were in the areas you were going to work?

(Answer) - We used area dose rates for the estimates.

(Question) - But somebody went in there to find out what they were, right?

(Answer) - Yes.

(Discussion leader) - We may have to put these people in heavy rubber suits to shield out the Beta; if we roll a rubber electricians' mat that is 3/8" thick on the floor; if we put aluminum plates in their rubber boots, we may be able to cut the Beta exposure down, more so than the gamma. We could achieve a 5:1 ratio with a lot of effort and we have to exert that effort.

Even if remote decon only gives you a DF of 2, that also makes a difference in the total potential man rem of 2. It may be advisable to do remote decon simply because of the man-rem budget. Especially if we're talking large numbers of man rem.

The whole picture is that you're doing this to reduce your total man rem dose overall. While the DF may be an important element the ultimate objective is to keep the man rem down.

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(Comment) - There is a limit to the effectiveness of the remote decon because of internal contamination of the concrete block, of the insulation, etc. The only way we're going to get rid of that is to discard them.

(Discussion leader) - That's true but you're not talking about either do remote or do manual decon--you're going to do them both, probably. There is disagreement as to whether we're going to do any remote decon. We're trying to resolve that. Obviously, one of the criteria for remote decon is to minimize the water volume, so is it best to start with small quantities and work our way up or is it best to hit it with a large quantity of water? Let's start by discussing quantities, then move into a logical sequence in terms of using water, steam, detergents and chemicals, etc. The original study talked about upwards of a million gallons--that was about a minimum. One of the biggest things you have to deal with, if you can do remote decon, is the tremendous volume of water that must be used (in my opinion). Are there any comments on minimizing water volume?

(Comment) - Unless you use steam. The SL-1 presentation mentioned that steam was very effective. That was steam applied directly to a surface as opposed to steam in a remote sense coming through a spray header. I don't mean through a spray header, I mean through a remote nozzle, mounted somewhere that would swing around in an arc. This would steam blast the surfaces.

(Question) - In the case of the surrey decon and decon of the containment--did they work from a scaffolding? How did they do the dome?

(Answer) - The scaffolding was put on the polar crane; it was tricky.

(Question) - Would the use of heated water as opposed to water straight out of the tank have any effect?

(Answer) - I think using heated water would be more effective and less volume could be used if the spray nozzle were close to the surface being worked on. Once you get out several feet, the spray water cools down pretty fast. We had talked about having water as hot as possible but then we may have the containment no longer at atmospheric pressure, or slightly negative. But you get better solubility if the water is hot.

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(Question) - If we do remote decon, how should we go about it? How do we evaluate whether it's doing any good?

(Answer) - If you clean up the water in the sump and recirculate from some time, take a sample in the sump; if the activity is gone up then you've done some good. You have a means of remote spraying, collecting of water and then determination if anything has happened.

Curies shouldn't be a measure of how effective you are. If you don't make standardized dose rates and base your effectiveness of decon on that then you aren't telling yourself anything.

We may be losing a lot of time here where we could be just recirculating the thing and taking advantage of this time. But we don't have permission, right now, to touch the water in the containment.

(Question) - What would happen if we injected heat into the liquid in the sump?

(Answer) - You'd simply accelerate that phenomenon that's going on now of the "cold-wall" effect [evaporation/condensation] that we have at the top and simply force the thing to do its own decon.

(Question) - If what we've got going now is at some rate, say "x," why not quadruple that?

(Answer) - You're not sure that's a good process yet, though, because of the crystals that may be precipitating out at various locations. Is that going to be a problem for us?

(Comment) - But here's a way to use the sump water and do remote decon with it and never have to process anything.

(Comment) - It's going to take a lot of heat, though.

(Comment) - Agreed, but heat is cheap. Hopefully, couple that with doing a reactor building purge.

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(Discussion leader) - We're trying to get permission to do reactor building purge and if you start heating up and making some other isotopes airborne, that may cause a problem.

(Comment) - You'd just have to wait awhile before you could purge. Stop heating the pool and then wait awhile.

(Question) - Are you, in fact, generating another problem by heating the pool up and getting some of the stuff that's down there started going up that would not otherwise?

(Answer) - No, because if you look at your volume reduction systems basically they're operating with the principle that you're distilling water.

Don't take great solace in the fact that you have "rain storm" in there because there's a very high probability instead of coating it evenly for decon, it's going down in rivulets and things like that which is not covering a great deal of the surface. Also the volume of water involved is relatively small.

That's a problem with the remote spray heads--you've got no assurance that there's going to be a smooth sheet (except if you have a high enough volume).

Also, if you start heating up that water you're going to accelerate corrosion effects.

The problems of getting a heater in there of any size seem very difficult. But the idea deserves some evaluation.

(Comment) - When the sprays were on during the test at Zion it was very turbulent in there. On unit 2 there were people inside and the wind currents are pretty strong in there. This was without ventilation just at the operating deck in unit 1. Things were whipped around. There was no equip inside--only concrete. There's an internal test report that our engineering dept. gave to the NRC at the time. It was never published. It probably is on the Zion docket on unit 1.

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(Discussion leader) - If we're ever going to use the rain phenomenon, the next few months is the best time to do it, because it's cold.

(Question) - What about accelerating rain by spraying steam through the spray nozzle or other penetrations rather than by heating up the sump. The amt. of heat added would be negligible but the amount of humidity would be greater.

(Comment) - What has been the experience of the people here in decon (hands on without the use of a hydrolaser) by pouring water down the walls. Why did you use the hydrolaser instead of just pouring the water down the walls?

(Answer) - Our experience has been that if you spray activity with a mild acid solution on a painted surface, you can take a hose and very little activity is left. I'm having trouble believing that this stuff is imbedded in the paint. I don't know anything about the temp.--did it get high enough to soften the paint and trap some of the activity in the paint? On a cold surface, I'm surprised that the paint is not releasing the activity.

We have experience with both painted surfaces and bare concrete. Our experience with bare concrete is if there is something that you can see, feel or wipe off, that can be removed by high velocity spraying--probably not by low velocity spraying. For painted surfaces, we've heard of contamination seeping out. Our most common experience in that area has been painted casts. You can clean the cast up to where it's smearably clean. But you can go back in an hour and it's contaminated again just from activity back out through pores in the paint. In some of the tunnels and other rooms, a very mild wash on it takes off a surface contamination. A spray hydrolaser takes it down to where you can go in and do a hands-on decon. About 250 lb. pressure at the nozzle, 3 gal/minute.

Our experience with unpainted concrete surfaces in our steam generator cells has been to go and start at the door of the cell with a fire hose (not turned on high pressure but fog spray) and flush it all back toward the sumps and it removes anything smearable. The pressure's nothing like a hydrolaser.

Using the containment spray would do some good. Even if it reduces contamination by a factor to 2, it's worth it. You've accomplished something with zero exposure.

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(Question) - I've heard a lot of comments about volume of water. Is there any advantage to hitting it with a lot of water at one time, or is it better to build up the amt. of water? Any comments? Is there any disadvantage to building up?

Let me pose it this way. Instead of putting 250,000 gal. into the containment would it be better to start with smaller quantities, take measurements, increase the amount of water, take measure, and build up to some number based on the evaluation you do after small quantity of spray. That approaches your radwaste problem from a logical point of view. Will it cause any other problems?

(Comment) - It just lengthens the time.

(Comment) - It may not lengthen the time because if you spray 250,000 gallons and you have a limited ability to process that at some low gal./min. in the radwaste system your schedule may be limited by the radwaste side.

(Comment) - You're talking about incremental actions and you may end up using more this way than with one shot. The analysis should include how much you have to spray to get this sheeting action, and how long do you wish to continue it. Based on that, your minimum shot could be determined. Comparing results by both methods is ALARA. That's a reasonable approach because exposure reduction is volume reduction too.

It's important to look at the mechanism whereby you want to remove any surface contamination. One is erosion--just the flow of water over the surface. Another method may be to "solubilize" some of the deposits and then carry them away by erosion process. If there are any others, we should talk about those. Keying on those things, you could more logically determine the volume of water based on the flow rate and the length of time you'd want to subject it to that environment.

Everyone keeps stating that if we spray the stuff down, we're going to reduce the dose. It seems to me that there's a possibility that if we spray the stuff from the top of the containment down, and there's no guarantee that it's going to get all the way to the sump, we may raise the rad levels in the operating area where we want to work.

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(Comment) - I think the point is that you must start at the top and work down. If you can get the top and sides and the operating deck clean, then you can start there to work your way down even farther. It may be higher where you come in but then you go up to the operating deck and you can start working on the rest. If you use a large enough volume the deluge should sweep it right into the sump pump. You've gotten your upper elevation cleaned for free almost as far as dose goes. Deluge spray is effective, but you've got to continue it the whole way down to the sump. If your objective is to clean the top part of the dome and down the operating deck, that automatically puts you into steam. Steam is also more penetrating and will give you access to certain surfaces where water won't, but steam doesn't have the deluge quality of the water to be able to sweep it.

(Question) - Haven't we heard that fog nozzles are just as effective in moving material to the drain? You're really only going after that which is smearable. The idea that you're going to really get the energy onto that surface is not possible with those nozzles. Aren't you back to steam as your only shot then? Could your total water flush be minimized by starting with steam to wet the surfaces pretty well and then follow up with some kind of flush of lower volume? What's the surfactant properties of the sodium hydroxide and borate? Is it a good surfactant? Like a detergent?

(Answer) - It is. In that case, the solubility may be much enhanced by the fact that you've got the hydroxide.

(Comment) - The steam might cause it to run down the wall into crevices where it would be harder for water to flush it out with a sheeting action if you did the steam before the water. What about that?

(Answer) - Steam will only condense on those areas which have a heat capacity to allow you to condense. If you don't have the capacity for condensation, it won't.

(Question) - You mean any place we have a cold wall?

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(Answer) - Both temperature gradient and heat capacity have to be present to condense the steam. We're saying that we have a cold wall, primarily on the dome. There is a 120' riser going up to those spray headers. I doubt if you'll ever get any steam out of them.

(Question) - You've got a tremendously long steel riser going up the base into the dome. How are you going to pump steam through there? It's going to condense and you're going to end up with a 120' column of water you're trying to pump steam through.

(Answer) - You can't change a water system into a steam system. You can get steam into there without using the existing spray system. By using another system. Not using the sprays.

(Question) - You want the steam near saturation, don't you? You want it right on the verge of condensation.

(Answer) - We may want superheated steam because we want it to distribute itself before it condenses.

(Question) - Have you tried to duplicate a painted surface outside the containment using whatever's in the sump? I understand you can get a sample.

(Answer) - We're evaluating the possibility of using some sort of test lab to simulate it. One of your critical factors is that polar crane. You've got to remove the major components up there to clean it and make sure it's in very good working condition. We mentioned this morning that remote decon could have a positive effect on the polar crane itself regardless of what happens to the contamination that's washed off the crane. It could certainly expedite getting to that crane and working on it to refurbish it. It is intended that that piece of equipment play a major role in the recovery effort. That might be one of the advantages of remote decon.

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(Question) - Why couldn't you spend some money on a crash basis, to build a model of this thing and simulate by using the chemicals we think are in there? Using that model we could determine whether the steam can be used and study to what extent the chemicals can be diluted using nonradioactive materials.

(Answer) - The only problem with that is the time involved. If we could keep it simple--rough out something in carbon steel that would thermodynamically model this thing--just something that would give us some insight. We could simulate the spray headers and study it.

(Comment) - The temperature gradient those materials endured during the incident is not known. If you're not simulating exactly those conditions, it will give a completely different answer. Simulations, in my experience, just don't work well in the case of decontamination.

(Comment) - You're testing for two things: How good is the decon? How good a coverage are you getting with the spray? I think you can separate those by testing the coverage on a mock up and testing the decon. effects on a sample in another test.

(Comment) - They know, pretty much, what the coverage is going to be. There's the question of the rivulets coming down versus the sheet coverage; the thermodynamics, how much swirling around you're going to get. How effective will that be in reaching the lower levels.

(Question) - What is the main objective of this decon job? How will this fit in with the recovery program total? Why are you in such a hurry to get to the polar crane? I don't hear this thing as part of an overall approach to some problem. That has to be developed because it's not obvious to me why you're in such a hurry. It seems to me, you've been talking about remote decon in isolation and it seems your objective should be "what the decon can do."

(Answer) - It has been recognized that there is a lack of an overall recovery plan that gets down to detailed objectives for each phase. That overall plan is in development. There are some major milestones that have to be met; one is containment entry, the aux building cleaning, reprocessing of the water in the aux building. The milestones in the containment and the remote decon is just

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one--there are probably other things once you get inside. Maybe you'll start hauling some of the equipment out. As far as other remote decon methods, one thing we found to be successful in our steam generator domes and in other areas is a device known as a gyrojet. There are different types. There is a spray ball and a sidewinder type. It'll cover 360° and puts out a pretty high pressure spray. It does a radius of 10-15' easily. These could be set up and allowed to run.

(Question) - What would be an acceptable level of contamination after decon?

(Answer) - We'd like to get the background down as low as we can get it. At other plants, even during normal refueling, you're going to have a background below which it's not worth trying to clean up. There's a certain contamination level where it's not worth trying to clean it up any more. We would certainly want the contam. down to the level where we would not need respiratory protection all the time.

There's a trade off as far as ALARA goes. You're going to be spending large quantities of time in the containment after you "finish cleaning it up"--you're re-installing for the eventual recovery. We would like to have that baseline, both contamination and radiation, as low as we can get it. You can't spend an excessive amount of time, effort and man rems getting it to a point. So, at least, we'd like to get it cleaned up to a point where we don't have to use respirators.

(Comment) - You've got quite a resource of people here who have got a lot of expertise and you've only had a few hours for them to provide information for you. It might be good if you requested everyone to go back and compile pertinent reports that they might have, particularly where they might have inter-office correspondence that's taken a long time to develop. You can probably get a lasting effect if people will provide you with material in writing, more than you can with the collection of ideas here.

(Discussion leader) - We'd appreciate that. In a forum such as this, things sometimes come out that you could never find in a bibliography. Any help would be appreciated.

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(Comment) - If the objective of the remote decon is to allow people to get closer and make entries, then you have to remember that your general cleaning of surfaces does not necessarily reduce the field. Also, the chemical composition and the solubility of the particular isotopes that are contributing to the problem have an impact on whether or not gross flushing is an advantage over slow, low quantity water. We find that in decontaminating reactor facilities that paint and concrete surfaces can be decontaminated from gross contamination. We've run into problems with concrete surfaces when you try to get them down to very low levels. You end up where the porosity of the concrete is very deep and it appears to be fixed contamination and you must remove the concrete surface. Also, you have a similar problem with painted surfaces where the porosity is less and you can get them down to a lower level. However, you can never get them perfectly clean without removing the paint itself. The other consideration I think must be made is the effect of any gross cleaning and the materials used on the total plant itself. Someone mentioned that you might be moving the contamination from one area and moving on to something that is now of lower contamination but might be more difficult to clean in the future. I think that the point that was brought up here earlier is that before you begin any decon method, the objective must be clearly defined. The total plant must be considered.

Also, we find that a very effective material for decon surfaces is a foam cleaning technique. The advantage of that is that it grossly reduces the contamination and at the same time minimizes the amount of liquid that is generated. In our operations, we consider the personnel exposure first and safety, then the amount of waste material that is being generated by the plant.

Any water processing system that's being considered (the volumes) I think you must consider redundancy. If you're putting in an evaporating system, i.e., you have to consider that the evaporator is THE key component and if it fails or needs maintenance, while it's down, you're not moving or getting rid of any of your contamination water. So, if you're putting a small evaporator in, you might consider two evaporators. With the ion exchange system in removing a bed it would be nice to have a 2nd system on line so that you can be constantly moving the inventory.

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(Discussion leader) - Let me summarize the major points at this time:

First, we need to get a better handle on the overall objectives of decon. (Both radiation levels and what kind of contamination levels are we willing to accept when it's done.) Objectives in terms of the overall recovery effort.

Another message that I'm receiving is that we ought not to allow the mind set of current radwaste technology and capability to dictate the decon process. We need to take a look at the best way to decon and then look at radwaste.

I heard a lot of comments on testing surfaces—both for and against. It's quite possible that we'll do that later.

There have been comments that remote decon at any level of effectiveness may still be an acceptable alternative because of the man rem picture. Part of the overall evaluation has to be the man rem, and if we're talking about large potential man rem, then even a small effectiveness on remote decon may have a big impact.

A lot of good comments on various techniques for remote decon using personnel and other means that could possibly be more effective than remote decon using containment sprays because of the directional nature needed.

They're the main things—anyone care to add anything?

(Comment) - I'd like to add one example to overall man rem reduction for even a slight reduction in contam. levels. In our fuel storage basin, the dose rates were 7 mr/hr for operators handling fuel. We thought with 7 mr/hr that was nothing to worry about but it turned out that they spent so much time there that over a year's time, they accumulated quite a bit of exposure. What we did then, was lower the water level in the basin and did a water flush on the sides of the basin and reduced the dose rates to 3 mr/hr. We've saved about 30 mr/year.

(Comment) - Another thing is the true value of the entries and what can be learned from the entries in terms of the data collected. What we might be able to do with coupon samples, then direct that information to help firm up the decon. plan.

EXOTIC DECONTAMINATION TECHNIQUES WORKSHOP

DISCUSSION LEADER - TOM PATTERSON (BECHTEL)

Exotic Decontamination Techniques Workshop

Discussion Leader - Tom Patterson (Bechtel)

The purpose of this session is a working session. I'd like to have the people with the expertise contribute their thoughts to the session.

We say "exotic decon" and some of the things that come to mind are over and above the hands-on scrubbing decon methods. Some examples are hydrolasers, electro-polishing, grit blasting, high impact ice blasting, Freon type methods, chemical solvents, foam, vibratory finishing, fuel fragment dissolution, concrete spallers, and strippable coatings. These are just some of the decon methods that should be discussed in greater detail and added to in this session.

From the standpoint of TMI II we're looking at many, many things that might require decon. At the moment, as you know from previous sessions, the main contributors in the containment were given for decon purposes. We're working on a technical plan for the decon of the containment and everything inside. In our review of the containment and the various components there's various items where we're not sure which way we're going to go from a decon standpoint. I have a list of items that I'd like to have discussion on and perhaps have ideas on how we might decon these items. The list is as follows:

One of my main items is reflective insulation which should be a very interesting topic. Another item is reactor coolant pump motors which we'll want to get into on how we can decon those to the point where they can be sent out and rewound or refurbished on site.

The containment itself, but I'm not sure that's really a subject for here. We might come up with some methods for decon of the containment dome rather than the hands-on scrubbing down of such a massive area.

The duct work in the containment. We hope to re-use that duct work at least for the time we're in there for decon of the containment. We need that ventilation and cooling in the containment.

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The polar crane is something we want to use immediately and will be very valuable in the containment. We need to come up with some good ideas for decon and refurbishment of the crane.

Other items that will be coming up are supports, especially reactor coolant system supports and snubbers. That could be a major effort in decon.

Some other areas that we might have problems with might be the upper internals of the reactor vessel, the lower internals or core support, control rod drive mechanisms, reactor vessel head, pressurizer, containment coolers and the various tanks and pumps in the containment. There are many other things but these are items we're not sure of procedures for decon.

Reflective Insulation

From the beginning most people have felt the reflective insulation at TMI II, if contaminated, should be discarded. It's my feeling that if we can come up with some means of decon it would be very beneficial from a cost standpoint. The insulation at TMI would probably run around \$3 million and it would be very economical to reclaim it unless the man-rem exposure in reclaiming it would be so high we couldn't stand it. We discussed this at Bechtel and didn't come up with anything outstanding to decon this insulation.

Reflective insulation is basically stainless steel and it's in thin sheets, about five sheets, each approximately 1/16 inch thick. There are air gaps between each sheet and at the end it's (refers to illustration he is making). These come in large sheets - say 7 foot sheets. They'll be wrapped around half of the reactor coolant pipe itself.

(Matasa) - They can be taken apart?

(Patterson) - Yes, these large sheets are easily separated and are strapped onto the reactor coolant pipe, strapped onto the steam generator and pressurizer.

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(Wheelwright) - Do the multiple layers separate?

(Patterson) - No, the layers are tack welded together into one sheet. Air and water (if it got into the internal area) can flow through the layers.

(Allen) - What is the spacing of the layers?

(Patterson) - The spacing is about 1/2 inch and the total thickness is about 4 inches.

The reflective insulation is manufactured to pretty close tolerance because the air gaps must be very precise and that's how the insulation works.

(Wheelwright) - What maintains the separation and what is the separation?

(Patterson) - The separation is about 1/2 inch and there are spacers. It is all stainless steel.

(Arrowsmith) - What about the end pieces? Did you decide we could or could not bend them up?

(Patterson) - The end pieces should not be bent up.

(Arrowsmith) - So what is the gap between the downward protruding section?

(Patterson) - This is a very small gap, about 1/32 in.

(Matasa) - Can you take each one apart?

(Patterson) - No, you cannot take it apart.

(Patterson) - This is one item that would have to be discarded if it is contaminated, and at a replacement cost of about \$3 million. The reason it probably is contaminated is because the air flow in the containment was contaminated and probably got into these areas and it is probably contaminated throughout. We must

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assume that it is completely contaminated throughout. We must assume that it is completely contaminated throughout for the purpose of decon planning.

(Comment) - When you say contaminated, are you concerned about the smearable contamination inside or about the dose?

(Patterson) - We are concerned about dose, but in the end we'll also be concerned about smearable because it will continue to come out in the containment during normal operation as the air flow passes.

One idea was "how about chemicals?" Another idea was bi-polar electropolishing and maybe we would want to go into a bit of detail there.

(Allen) - Is the top essentially open so you have open channel going down through the sheets?

(Patterson) - The top is rounded but when you look down from the top you just see one sheet of stainless steel.

(Comment) - Is it possible to cap the ends of it thereby being able to forget about the contamination between the sheets? Cap ends with plastic or something?

(Patterson) - You probably could, but if you wanted to reuse it you'd want that material out of there for airflow.

(Comment) - The moisture in there would blow up otherwise. What is the total volume or amount of this material?

(Patterson) - All the reactor coolant piping (about 30 in. diameter piping) at TMI, pressurizer, steam generators which are 70-80 ft long and 12 ft in diameter have this reflective insulation. So, we're talking about quite a magnitude of insulation.

(Question) - You put this on in two halves - are the mating surfaces solid?

(Patterson) - No, it's not a tight fit - it's spring clipped like a lunch pail.

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(Comment) - It seems to me that the most exotic thing you've got to consider is sort of a "through put" kind of system. It seems that chemical or electropolishing or a number of techniques would do the job as far as decon but you need to think big in terms of handling all that massive hardware for decon.

(Patterson) - We're prepared. The first objective is decon as much inside the containment as possible and then secondly to have a building (that will be called the containment recovery service building) right outside the equipment hatch which will contain decon techniques.

(Comment) - Talking about electropolishing, if you had a couple tanks about the size of this room, you're talking about a limited throughput, and most all decon is fairly labor intensive. You've got a lot of things to trade off whether it's recoverable materials or labor and the way you go about it. If you had a system where you could minimize a lot of labor and time, you might be able to come up with something that's reasonable.

(Patterson) - If electropolishing would work and you could use a large container, that could be designed into the containment. I'm not so sure that electropolishing will work.

(Arrowsmith) - It's our guess that it will not. There doesn't seem to be a way to use electropolishing.

(Matasa) - There is not a way to get in. A method described yesterday is use of nitric acid and ammonium chloride. I have used this method for removing scale off stainless steel and it worked very nicely.

(Arrowsmith) - These are highly polished surfaces and when we're all done with them, they have to be that way. If any chemical solution used on them etched the surface, that's the end of the insulation.

(Matasa) - I have an answer to that too. Nitric acid and fluoboric acid - this mixture leaves stainless steel clean and shiny and bright. The other mixture gives a rough surface if on the surface more than five minutes - you get a dull spot. With nitric and fluoboric, it does not happen.

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(Question) - Do you know what the ratios are?

(Matasa) - I would say one part of fluoboric vs twenty nitric acid.

(Question) - Has a cost study for the decon been done?

(Patterson) - The approach we're taking now is to see what methods are available to decon and then go from there and do a cost benefit and man-rem (ALARA) assessment.

(Question) - Have you considered dry cleaning it using Freon; building a tank, putting it in there, sealing the tank, process the Freon through your veins and back out again and keep the cycle going?

(Patterson) - No.

(Arrowsmith) - There is one step beyond that. The Freon can carry various cleaning agents through in hopes that the cleaning agent plus the Freon would remove it. The Freon could then be processed for reuse.

(Comment) - If the Freon did, in fact, take the particles with it, it might work. We do know it does work with dry cleaning and with the ultrasonic Freon cleaners that we're using. We clean pipes and so on with it.

(Question) - Ultrasonic Freon cleaner?

(Answer) - They have ultrasonics and Freon. We have one at TMI right now. We're doing various electrical components and so on. I know we can clean with Freon.

(Question) - Essentially what would you do? Blow it through?

(Answer) - Pump it through.

(Question) - Is this Freon 113?

(Answer) - That's what I would recommend right now.

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(Question) - Do you put it in an enclosed chamber and pump Freon through it?

(Answer) - The Freon 113 is pumped through.

(Arrowsmith) - The important thing would be, "what kind of layers are there and what's soluble?"

The reason for using Freon for the bulk of the carrier is that it is very inexpensive to reprocess as compared to water. We have to get in there and find out what's on there, or maybe your cookies are going to tell you as you take them out of the penetrations. Find out what will solubilize them.

(Matasa) - Most likely, they will be salts.

(Arrowsmith) - You'd expect boric crystals and NaOH on those one way or the other, especially on the outside. You may have to heat it up then, flushing water through won't do it. You might also have to do something with the outside before you tackle the inside because I think you're going to have two different characteristics.

As far as taking care of the outside, if you can't wash it off with a hydrolaser (and you may not be able to point a hydrolaser at those anyway because they're not very strong), electropolishing would take care of the two outer surfaces nicely either by immersion or right in place by a swab type arrangement. That could be done; there's no question about that. It's what's inside that's the real challenge.

Maybe you ought to consider a two step process where the insides are very low level and what you're trying to do is get to a point where when you heat them up again, on the next operation, you won't have airborne. Maybe there wouldn't be an exposure problem from inside.

(Matasa) - Maybe not all the panels will be contaminated in the same way. If you have a dual system, then you will decide with those which have actually been in water then you'd have to use both of them.

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(Comment) - You must be careful that the electropolish electrolyte doesn't set up what's on the inside, too.

(Arrowsmith) - That's right. It's a complex problem.

(Comment) - Tom, I think from the way the incident occurred and the activities going on in there since then, the majority of your contamination would be on the outer surfaces of that material.

(Patterson) - I think you're probably right.

(Arrowsmith) - The majority of spills don't always go through the insulation and I think you're going to find most of it on the outside. A hydrolaser wash may get you down to where you can leave it from that point in time and it may get rid of most of the loose surface contamination.

(Patterson) - That is very possible and I hope that's going to be the case. We're trying to plan now, in the event that that is not the case.

(Comment) - I'm convinced that you don't have a decontamination problem that hasn't been solved before. I don't think you have anything that can't be cleaned up in some way or another. If one technique doesn't work, then you have to go to another. I haven't heard one technique that hasn't been used in one form or another. What I visualize you need is a major facility (you're talking about millions of dollars worth of equipment that you want to clean up), where you might have staging processes where you put the equipment in a giant assembly line and you hit it as it goes through this assembly line with some of the simple things. Maybe you got it hanging in a big shower system or a vat and as it goes through you check each stage and if something has cleaned it up, you take it out of the system. It then would go into storage. If it would not have been cleaned, then it goes to the next stage. You've got to think in terms of some huge through-put and assembly line process or you're whipped before you start.

(Patterson) - We're looking at that. This meeting is to determine what types or things this massive facility should have.

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(Hall) - The first step in determining what that facility is, is to characterize the problem. There are two major areas - the outside and the inside.

(Matasa) - I think we should look into the past because every problem has been solved and also into the future and try to devise methods which can be applied to other processes. I don't think that everything has been already done.

(Patterson) - We have to consider things that haven't been done before. That's one of the purposes of this workshop. What in addition over and above what's already been done can we put into our facility either inside containment or in the decon facility outside the containment.

(Wheelwright) - This particular material is probably one of the better examples of a hazard that we run into in decontamination. There's a good chance that most of the contamination is on the outside. There is also a good chance that you will contaminate the inside if enough care is not taken in the initial stages of decontamination.

To clean up the outside, you could possibly expose the thing to an equivalent size heating unit and air flow unit in a closed atmosphere and see if it's going to off-gas at all when subjected to max temperature it'll ever see again in life, and then do an infrared scan to see if the polish is adequate to do its job and then forget about the inside of it entirely once again.

(Patterson) - Maybe the solution is to forget about the inside. Hopefully we can.

(Hall) - Can you not take a section of that at the time of the first access and set up a test to find out whether that inner stuff will migrate?

(Patterson) - As long as we get a representative sample, we probably could get a piece of insulation. Just make yourself a big pipe with heaters inside and strap it on.

(Matasa) - Could a piece of this insulation be obtained for testing?

(Patterson) - Yes. We can get some that looks exactly like what's in TMI.

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(Arrowsmith) - There is a family of chemicals that is used for chemically polishing stainless steel. That might be another approach. It's literally the same as electropolishing.

(Matasa) - I've tried this "family." One of them is the acetic anhydride and nitric acid, too. They do not dull it and even brighten stainless steel.

(Patterson) - This is a very high polish finish - a mirror finish.

(Arrowsmith) - These solutions were designed to compete with electropolishing. They do not provide as good a finish as electropolishing but would probably be acceptable for your use. Tests could be run.

(Matasa) - You cannot produce as bright a surface as with electropolishing, but an already electropolished surface will not be dulled.

(Arrowsmith) - The question would be, can the solutions be used in such a way that they will not recontaminate? We want to remove it and keep it in suspension. We don't know how the family of chemical polishes would behave once it becomes a contaminated bath.

(Matasa) - The next question would be how to remove the contaminant?

(Arrowsmith) - We're talking about large volumes and we're going to have to process or discard.

(Patterson) - We have to keep the processing in mind.

(Question) - Is this insulation tack-welded to the pipe?

(Patterson) - No, not the one on the pipe. It's fastened on with clips.

Reactor Coolant Pump Motors

Reactor coolant pump motors at TMI are motors that are not made any more. The company that made them is not in business any more - at least for the manufacture

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of motors. One possibility is that we might have to rewind the motor and reuse that motor. Another possibility is to get another type of motor. That will add to the problems of support systems for the motor and even possibly the mating with the reactor coolant pump itself. Let's say the motor is contaminated and we want to reuse it and to rewind it - where do we go from here. It weighs about 70 tons or more and we'd like to send it off site for rewinding. It ran during the time of the accident and therefore the windings are probably contaminated. How can we get that motor to a point where we can ship it to a factory or maintenance shop for rewinding without exposure problems?

(Question) - Is it a sealed motor?

(Patterson) - It is sealed but it is air cooled so there'd be air flowing through it.

(Comment) - A lot of them have their own fan inside the motor with service water or cooling agent where the air passes through. The motor itself is absolutely sealed.

(Patterson) - I think, in this case, there is air passing through it.

(Question) - Can you strip the windings at TMI before you ship it? In other words, not strip a lot of the minute surfaces where you're going to get contamination.

(Patterson) - I don't see why it couldn't be stripped. I don't know how much exposure we'd get doing that if we didn't decontaminate in some way before doing that.

(Testa) - I don't want to sound repetitious, but you could clean it with Freon. Again, it's a proven fact that you can clean motors and you can turn the motors over in the Freon but you must immediately regrease them. If you have a container to put it in or a bag to circulate this Freon in and out you could decontaminate it.

(Matasa) - Has anyone tried doing anything with Freon vapors and not the liquid? Do the vapors carry out contamination, or just the liquid. If you could use the technique of carrying with the vapor then the Freon would be wonderful. You wouldn't have to dip the whole thing, just a current of vapors passing through.

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(Testa) - Yes. This can be done.

(Patterson) - Would you run the motor?

(Testa) - In this case, I don't know if you can any more - the windings are gone. We want to get the gross contamination off. Once you get the gross off, then you have to take another step.

(Patterson) - Then you could probably put it in a Herculite or polyethylene bag and circulate the Freon through it.

(Matasa) - Or you may have a system like a Soxhlet device for extraction. This is a device which allows a recycling of the vapor, condensing and doing it over again. In the liquid stage, you get the product which carries the contamination. The vapor will be always free of contamination and will remove some more contaminant and bring it back in the condensation pot.

(Question) - From the standpoint of Freon though, don't we need a velocity of some sort going across the surface so it's not in an atmosphere of Freon?

(Answer) - It's got to be pumped through or pushed through.

(Patterson) - What kind of decontamination factors could we expect with Freon?

(Testa) - We've been able to do electric drills and have them released coming out of the auxiliary building. Bud Arrowsmith could tell you more. They have a Freon bag they just purchased. This bag was designed to go over small motors. They pump Freon in and back out again.

(Allen) - There is one point, though, I'm not certain that the additives are completely carried along with the vapor. The other thing of course is that it's just good for loose surface contamination, and effectiveness would depend on the nature of the contamination in this case.

(Patterson) - We're not exactly sure of the nature of the contamination - this will be one thing we'll want to find out early in the game.

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(Question) - What's the cost of a motor this size?

(Patterson) - I don't know. It's about 9000 hp.

(Matasa) - I would like to question the basic idea of using Freon. I do not have anything against a very volatile medium which can be condensed and evaporated fast but I believe that Freon besides the fact that it does meet two of those requirements, it's a poor choice when you want to get rid of salts, cations and so on. Why can't you use a polar medium which would have the same characteristics. You want one?

Ethylene oxide. Maybe to a lesser extent - methanol. It is known that Freon will not dissolve a salt. I'm pretty sure that methanol will dissolve more salt than any Freon. The basic idea of Freon is nice but the specific agent which has been used doesn't fit from the solubility point of view the requirements. How do you comment on that, Mr. Allen?

(Allen) - I think the key in the use of Freon is the additives. That's why I broached the question. You can use Freon as a carrier for various compounds, including possibly some of the same ones you've mentioned. That's why I'm concerned with the vapor as opposed to the way we normally do it with sprays or immersion. The basic advantage with the Freon is the fact that it can be purified. Our tests show that Freon itself will become contaminated and recontaminate. The key to its use is having a purification system. That's what you find inherent in these commercial systems - the ability to purify and recycle, then put in whatever additives are required for the particular application.

(Matasa) - Freon picks up things in a difficult way and releases them in an easy way, so you cannot have them both. The other one picks up things fast but it will be more difficult to remove them. If you are doing it by evaporation, I believe other means can be used too.

(Patterson) - If these additives are put in the Freon, won't that make the processing more difficult?

(Allen) - The processing essentially removes them along with the contamination that's carried along.

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(Patterson) - Removes the additives?

(Allen) - Yes, removes the additives - not 100%, we haven't completed our study, but you do have to replenish the additives.

(Patterson) - Is there any chance the additives will stay on the component and maybe cause damage? In the use of the reactor coolant pump motor, we probably will have to rewind it, but there will be other parts of the motor that we will not want to damage.

(Allen) - We haven't seen any indication that there's a buildup of these additives or retention of them, but we'd have to look into that.

(Patterson) - In my discussion with various people, I've found Freon is being used more and more today. I'm not sure what additives we're talking about, but Freon is in major use now.

(Comment) - One thing to keep in mind is no matter what exotic methods we use, when we're finished we must solidify this waste for disposal. No matter what we come in with, we must prove we can dispose of it before we use it.

(Matasa) - How can you get rid of the contaminants in Freon? If I understand well, your way is distillation. Evaporation of the Freon and condensation of it. Is that correct?

(Allen) - The unit we're discussing employs filtration, distillation and also removes water by chilling. I'm not completely conversant with this unit. We've just purchased one and are starting our evaluation studies.

(Matasa) - You are only mentioning physical means which may apply in the same way to other agents. I want somebody to consider replacing Freon for some specific case. In the case you have something that is soluble in methanol or acetone, you cannot use those, you have to use Freon. There may be cases when you can use with better advantage something which is polar and which dissolves. How can you expect to dissolve salt with an oil? That's exactly the polarity situation with Freon vs.

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acetone - water and oil. You cannot dissolve salt with oil, but you can dissolve it with water.

(Patterson) - When Bud Arrowsmith gets back, we'll have him comment also on the use of Freon.

Containment Dome

From what I heard yesterday, everybody was using either scrub brushes - we have quite a large dome. The use of a hydrolaser was discussed; again, we have a large dome and I don't know whether this would be practical. I hope someone will comment. Fire hoses were mentioned, too. We might have a problem from the solubility standpoint according to the cookie sample.

So we have looked at some alternatives. We've looked at fire hoses, hydro-lasers, etc.

(Matasa) - You need to describe what we have to treat.

(Patterson) - The containment is the vessel that houses the entire reactor coolant system and various safety systems. A rather large building, 2.5 million cu. ft. of free volume in it. So, it is rather a large building, several hundred feet high. I don't know the exact dimensions, 140 ft in diameter, something on that order. Because of the accident the entire containment has become contaminated.

(Matasa) - Is that concrete that's painted?

(Patterson) - The containment has a steel liner that is painted with epoxy paints. And the purpose of those epoxy paints was number one for good decontaminatability. That is one plus that we do have. From a cookie sample that they have taken so far it appears that decontaminating that painted surface may not be as easy as we anticipated. We originally thought that the cesium would be in a soluble form and that the containment would just have to be washed down. We were concerned about washdown however, using fire hoses or whatever because of the volume of liquid waste that it would generate.

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(Wheelwright) - But the cookie sample probably isn't representative.

(Patterson) - It may not be.

(Wheelwright) - Because it was heated in the process of cutting it out.

(Patterson) - Yes sir, and we hope that cookie sample is not representative. We hope that really we can wash it down. But even so, if you are washing it down, let's say with a fire hose, you are talking about 100 gal. per minute or so from a fire hose, you are talking about a large generation of water. We're looking for other potential ideas someone may have to wash down the containment to minimize the amount of water that may be generated.

(Hall) - Check some of the new high pressure, rotating nozzles that are used for tank cleaning - rather large tanks in fact. They provide multiple jets. They do a fairly good job of cleaning without too much flow.

(Patterson) - No, I'm not too familiar with this - who manufactures these?

(Hall) - I'll get it for you.

(Patterson) - What would you do, put these nozzles

(Hall) - You may have to put several of them in there, but they will cover something like a 50 ft diameter.

(Patterson) - You would place the nozzle in the center of the dome?

(Hall) - No you may have to have more than one because your dome is more than 50 ft in diameter, or you could move it, rotate it in some way.

(Patterson) - Now on these nozzles, the only nozzles that I am familiar with don't get a very wide spray.

(Hall) - That's right. But this one rotates and it makes almost a circle of the enclosure - 180°.

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(Patterson) - And what kind of pressures are you talking about?

(Hall) - They are variable. There are all kinds of pressure ranges you can use.

(Comment) - Someone in there discussed the water type spray down yesterday. I've used a lot before. You can run air through an eductor at a couple hundred pounds or more pounds/square inch and educe pure water or water with solvent in it and spray it and you use a minimal amount of water. Instead of using a hydrolaser or a nozzle spray type unit that uses a lot of water to develop pressure against those flat surfaces. The water particles entrained in the air do just as good a job with 10% of the quantity of H_2O . I used it to clean the inside of a bunch of condensers in the Naval program. I built some of them myself to be used with very small quantities of demineralized water because I didn't want to have to make more and then get rid of it. It wasn't contaminated but the same principle would apply.

(Matasa) - Steam could be educed with air to minimize the amount of water.

(Question) - Have you considered using the foam that is on the market? The company is Atomics International. They have had good luck going in and decommissioning plants. The foam brings the contamination down, then they use a rinse on it. How is it cleaned up?

(Answer) - For cleanup, they have a means of reprocessing the foam afterwards. They suck it into a vacuum cleaner, then they have a defoamer that comes down over the walls and off the floor. It's supposed to be sprayed on the walls, allowed to sit and runs down the walls carrying contamination with it. It's a liquid type foam.

(Comment) - If heating the cookie caused the contamination to become harder to remove, then steam cleaning at very high temperatures might be a problem. You might make your contamination more difficult to remove.

(Patterson) - I guess the foam would be a similar principle to using a strippable coating. Coating it and then stripping it off.

(Matasa) - No, I don't think so sir. With foam, with steam, you can recontaminate. With strippable coating you just have this small piece - around it the same

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amount of contamination as before. With foam, steam or water you do not have any way of controlling the spreading of the contamination. What you need is something very localized.

(Patterson) - We're also talking a pretty long distance. It's probably at least 100 ft from the operating deck at the highest elevation in the containment to the dome. You might build staging off the polar crane.

(Question) - Do you plan to spray this or clean it starting at the top or the bottom?

(Patterson) - For the dome we will start at the top. Start up and work down. There is a concern, that during our decontamination of the containment that some of the components that are not now that contaminated will become highly contaminated. They may work before decontamination and after, they might not.

(Hall) - You'll have to assess the cost of strippable coatings on that along with some of these other methods.

(Patterson) - I'd like to know how much of an effort that would be to put strip-pable coating all over the containment.

(Comment) - It might be the easy way. Yesterday, one fellow's comment on strippable coatings in one installation, on the walls they had a hard time getting the proper thickness. It was not giving the DF that they were getting on the floor as you remember.

(Patterson) - I heard that yesterday and then I heard another gentleman in the next discussion say that they didn't have that problem and it worked beautifully. Why?

(Matasa) - I can tell you why. There were two products. One was the Turco and one was with Imperial.

(King) - The one that I used was neither one of those.

(Hall) - I think that would be a matter of application control.

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(King) - My experience was that the vertical surfaces were extremely difficult to get the proper thickness, but I do realize - and I want to qualify that - I was using coatings that were readily available and I did not scan the market for the optimum coating for vertical surfaces and I appreciate that there are other coatings on the market that might have worked better. The particular one I was using did not work well on vertical surfaces.

(Patterson) - Do you have any comment on vertical surfaces?

(Matasa) - Yes, you can do it - to work on vertical surfaces as well. You have to design purposely for that. Contact the manufacturer for your particular application as far as the strippable coatings.

(Patterson) - With regards to Freon, Bud, what additives are we talking about? How will that affect the Freon process if we used it in the gaseous form instead of the liquid form?

(Arrowsmith) - Some additives are carried into the vapor and some are not. Say you put in 10% ethyl alcohol, to accomplish the cleaning job, it will go into the vapor and clean whereas water would not.

(Matasa) - Why did you select Freon and not methanol or acetone? Why a nonpolar liquid instead of a polar liquid which would dissolve better?

(Arrowsmith) - We try to keep away from all flammable solvents for nuclear applications. The idea, then, is to use a carrier that is very easy to process - such as 70-80% Freon, and then just a small amount of the cleaning compound. Then, perhaps, you could have that small percentage of flammable if you need it.

(Patterson) - Another thing, on strippable coatings, is the disposal. Would it be dropped in 55 gal. drums and compressed?

(Comment) - Either that, or you put in an LSA (Low Specific Activity) box and they have compactors that set right on an LSA box. For that amount of strippable coating you're talking about, it would be more feasible to use a larger container than a 55 gal. drum and compact it.

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(Matasa) - The strippable coatings are not a fire hazard.

Containment Coolers and Associated Duct Work

(Patterson) - We have five containment coolers and they consist mainly of a vane-axial fan for each one and then finned coils which are copper with copper fins. They're about 15 feet high and about 8 feet x 8 feet square. They supply the air to the containment and circulate the air in the containment and there is duct work associated with these coolers. Most of the duct work is carbon steel painted. Some is stainless steel, but most is carbon steel with a coating. Our concern here is that if we don't do something with the duct work and we use the ventilation system for venting and cooling the containment, that will continuously recontaminate areas in the containment. From the standpoint of the containment coolers themselves, steam cleaning is probably one way of doing it. Steam is used for cleaning even when it's not contaminated. The coils are steam cleaned to keep the fins clean. Some of the ducting is small enough so that you can't really crawl inside and do something with it. You may be able to drill holes in the duct work and do something on that order but I'm not sure how to approach the duct work and I'm looking for assistance in that area.

(Comment) - Hydroblasters are used in the Navy program for cleaning out small bore piping and duct work using a head that feeds itself through.

(Patterson) - This duct work is 48 inches square in some places. We do have some smaller ducting, too.

(Comment) - That hydroblaster pulls itself around 90° bends quite nicely.

(Patterson) - The ductwork is not smooth inside, it's got reinforcing channel inside to hold the ductwork together. It's designed for pressure (2 psi) so there is reinforcing steel all the way around the square ductwork which also causes a problem. Some of the stainless steel ductwork is round and won't be so difficult, but the square ductwork is going to be our problem.

(Comment) - Maybe you could go in and cut a piece of the contaminated auxiliary building ductwork out and analyze it, it would give you an idea of how contaminated it is on the inside, and what methods to use to decontaminate it.

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(Patterson) - That's a good point. On many of the components we have, a test sample will be the ideal thing. I perceive a problem, though, in just getting to the ductwork. The large ductwork doesn't present as great a problem as the small because you can get a small person in the 48 inch ductwork to clean it. The smaller ones will present a problem. Once you know what to decontaminate with, then you would even make a ball out of muslin floss and tie it and pull it through the ductwork; something of this nature.

(Patterson) - I think the problem there is that it's not smooth inside. The reinforcing steel will give us the trouble.

(Question) - Just how much of the contamination are you going to get out by coming through with something to take the loose stuff away? That's where the airborne problem is going to be. If that's fixed into the duct and no longer comes into the atmosphere, then it's no longer a problem. Pulling or pushing something through to take the loose contamination away is what you want to do.

(Patterson) - I originally thought we might be able to run high velocity air through that unit and clean it up.

(Comment) - We do develop airborne problems at times when we change fans because of the cracking of the ductwork as the new fans come on causing some of the material to dislodge. Eventually it would clean up.

(Comment) - If you're going to continue to use what you've got in there, the first thing you should do is put particulate filters over the discharges so that you don't spread it around the place.

(Patterson) - We had hoped to put particulate filters in the unit itself. I think you need them at the discharges because what you have in the vent duct now will work itself out from time to time.

(Arrowsmith) - What is the inside coated with?

(Patterson) - With an epoxy.

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(Question) - Has anyone taken a look at what it would cost to scrap everything in that building and start with the bare walls?

(Patterson) - That's an alternative except for major components. I don't have a cost for it.

(Comment) - Things like ductwork and cableruns and all that sort of thing where you just took the stuff out and decon and buried it, it might be cheaper in the long run.

(Patterson) - It may be. Some of the items it may be cheaper just to scrap and ductwork may be one of them. The only problem there is that we'd like to use that system right away and use it throughout the recovery effort.

(Hall) - How many outlets are involved in those five systems? There can't be all that many.

(Patterson) - There are quite a few and we would even add to that. We would like to build tanks inside the containment to isolate areas as the decontamination procedure progresses. We would like to supply those tanks with ductwork that comes off this system - that would be more outlets we would have.

(Comment) - With all the joints and baskets in the ductwork, it might be easier to disassemble it and clean it and then reassemble it, than to try and clean it in place.

(Patterson) - It could be disassembled. It is tack-welded.

(Comment) - I was thinking of getting some strippable coating in there to try and hold down the contamination. I might be going the wrong way in that line of thinking. It'll all have to come off one day. The quick way is to put filters on the outlets.

(Arrowsmith) - That would get you into operation long enough to take some samples and then decide how to do it. Another way would be to just fix it in place if you're going to just throw the ducts away and it's not a high exposure, you could just fix the inside of the ducts and let it set there and use the system. Fix it with

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a coating and then put your filters on as a second effort. That would depend on whether the ducts read 1 mR/hr in a field of 1000 or whether they read 1000. They could be very contaminated.

(Patterson) - They really could be highly contaminated as they, the coolers, were running during the accident.

(Allen) - It might be possible to use fixatives to decontaminate, thinking about something Ray King did in one of his buildings where he had some long tubes to decontaminate. You put in something like a balloon, but porous and coated with the fixative which is inflated up against the surface and allowed to cure and then stripped out from the end, like taking off a sock.

(Arrowsmith) - We had some tubes that were 7 feet long and, of course we couldn't do it with our arms, so we had to think of some way to do it with fixatives. We made a device that could coat the inside of the tubing. We put a cheesecloth layer saturated with the coating against the outer wall which solidified and then we reached back to the end and just pulled it out. It was like taking a sock off inside out.

(Question) - With the coating on the outside of the balloon?

(Allen) - It was cheesecloth, but the idea is to take it in and inflate it against the outer surface and strip it out bringing with it a lot of the smearable contamination or what potentially could become airborne.

(Arrowsmith) - There is another way. If the ducts are highly contaminated, and you have to decontaminate without taking them apart, you could use the dry ice blasting technique. There the nice thing is the abrasive disappears into a gas and you're left only with the loose contamination which you might be able to collect from the filters at the end and then recoat the inside. I can only see you doing that if the ducts were an exposure hazard. Holes would have to be drilled in the ducts to do that.

(Question) - How about Freon?

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(Arrowsmith) - It's another possibility. The vapor isn't very effective as a cleaning agent. If you want to decontaminate using Freon, I'd say spray it under the highest pressure that seemed reasonable. That is not a very easy thing to make a closed system out of. You don't want all your Freon to escape and destroy the ozone layer. You've got to think about using Freon in a more or less closed situation. The Freon itself wouldn't do it. There are some studies at Livermore on Freon to determine its effectiveness in cleaning. Freon in an ultrasonic cleaner maybe removes half of the particulate matter in a certain micron size. Spray at a few hundred psi removes something like 90%. I think they went up to 3000 psi before they got up to 97% removal. They were learning how to clean the laser amplifiers in the laser fusion system. So, there is some good data on Freon and how effective it is.

The only way you can get vapor to work for you is to allow it to condense on what you're trying to clean and run off. With the tests we've done at Battelle trying to vapor clean (just to suspend what we're cleaning in the vapor) it's not worth even discussing.

(Allen) - As we mentioned before, the additives, in general, do not go with it.

(Arrowsmith) - We keep talking about Freon but there may be things like it that could be used. We had some Swedes from their AEC at the laboratory a few weeks ago, and they said if they were to propose to use it in Sweden, they would not be allowed to because they are not permitted to use any new industrial processes which use Freon, and the reason is, of course, that we're still destroying the ozone layer.

(Patterson) - Speaking of other things besides Freon, it may be valuable to get a small motor and just have an R&D program and test some of these things you're referring to and see how it would clean up those windings. Electrical cabinets, cables, cable trays, and that sort of thing we'll probably discard. We'll probably discard most of the electrical components. However, from the standpoint of getting it out of the containment, getting it wrapped, boxed and stored onsite or even shipped offsite, the thought was that the surface contamination should be taken off. Right now, if you have any ideas on cabinets, cables, etc.,

(Testa) - On the cable, I believe you ought to strip the outer layer of rubber off, discard that as radioactive waste and the inner portion should be free of contamination

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and could go out as junk or be salvaged or whatever. Don't just take the cable and reel it up and put it in a box because you're tripling your waste.

(Patterson) - There's millions of feet of cable in there and it would be a tremendous job. How would you go about stripping it?

(Testa) - With all the mechanical engineering expertise, I'm sure you could come up with some sort of a stripper that would feed the cable in there and as it goes on through the rubber should be stripped off.

(Arrowsmith) - I'll bet that kind of machinery is in existence somewhere. In fact, we just don't know where to look.

(Comment) - I've seen a demonstration of Freon cleaning where the cable is run through and washed and comes out the other end.

(Arrowsmith) - The first choice would be wash the outside of the cable and another would be to strip away the outer layer and do it in such a way that you don't contaminate the inner part.

(Patterson) - It would have to be a massive process because there are millions of feet of cable and stacks and stacks of cable trays.

(Comment) - I would imagine as they'd come off the cable trays they'd have to be put on reels. Cable trays (about 4 inches in depth) are stacked to the top. Just to get these cables will be a tremendous job and then to talk about stripping them I'm not saying stripping isn't a good idea, it's just got to be pretty ingenious. Once they're on the reel, then you have a facility set up where you strip it off the reel.

(Arrowsmith) - That might be a secondary operation somewhere. Someone might even do it for the salvage value.

(Comment) - You won't be able to put too much of this on a reel because the penetrations are all plugged up for fire protection.

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(Patterson) - Some of these cable trays go for quite a distance before penetrating a wall.

(Arrowsmith) - One of the other alternatives if you weren't going to do any of that, would be develop a very quick method of sectioning cable tray in place and just chopping it off in 7 ft lengths to get it into your burial boxes and lay it in pieces.

(Comment) - I'm afraid existing boxes would not take the weight.

(Arrowsmith) - That would be something you should determine. How much would a tray weigh in a 4 ft length?

(Answer) - It depends on the thickness of the cable. You've got a number of thicknesses and weights. The copper in there is worth a fortune.

(Arrowsmith) - The salvage operation could be separate from the decontamination operation. Maybe you could have two categories: Things that are salvageable and, perhaps, you could make some money off them and other just directly discard.

(Patterson) - For salvage, you need a place to work and there'll be a lot of contamination to remove. Any place you take it or wherever you try to cut across it, you'll start to generate airborne and that could be a big problem. It might cost more to go to this major stripping effort than it would to scrap it.

(Arrowsmith) - I don't see that the stripping is a part of the decontamination effort at TMI because things must be done right away. The plant costs so much to be shut down every day that fooling around with the cost of that wire is insignificant. That's not to say that you ought not to be thinking of things that are valuable and could be processed later by GPU, or someone that contracts to do it.

(Comment) - If they'd say you could store that somewhere and do it later, I'm for it. But, don't forget, we're after volume reduction in this business too.

(Miscellaneous comments on possible reuse of the cable.)

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(Arrowsmith) - The discussion I've heard about the cable is that they didn't think they could requalify it because it has exceeded its dose life. They might not allow you to reuse it.

(Patterson) - There is concern regarding all electrical items in the containment that we could never prove that they're going to work for the next forty years and have another loss of cooling accident. That will be the design basis for requalification of the containment. We'll be looking at getting all the cable and electrical cabinets out of there in the best way we can and try to decontaminate inside the containment to some level and at least try to get some of the surface contamination off. Then the material could be taken somewhere.

(Comment) - Just look at the cable tray. Our experience in the auxiliary building was that there was never a good clean-up after construction and there's a lot of dirt, debris, etc., mixed in with the cables. We had to lift a lot of the cables up and clean with a vacuum right in place. Looking at this problem, I don't know what you'd expect to find in the containment. You might have to do a general clean-up of the tray surface itself before you attack the cable.

(Arrowsmith) - Has anyone ever tried using hydrolasers or other washing systems on cable trays. How effective is it?

(Answer) - They have been effective with hydrolasers. Here again you're making a big mess and using water.

(Patterson) - It could be a tremendous amount of water.

(Comment) - In the old days you could just blow it off with air. You will run into the same thing with the electrical cabinets. The normal way in the past was to open the door and take the air hose and blow it out. Now, you have to vacuum it.

(Comment) - Cable is pretty easy to decontaminate. You might just get away with wiping it down to reduce it to a reasonable level.

(Patterson) - Wiping it down just with water?

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(Comments on possible reuse of non-safety related cable.)

(Patterson) - Maybe another thing you could do would be vacuum. If you could get into these areas, take the cable trays apart and vacuum after it's dried out.

(Question) - But you would still end up throwing the cable away, wouldn't you?

(Patterson) - The safety related cable would probably be scraped and the non-safety related cable could be in another group and something could be done with it.

(Comment) - You also could use foam with a rinse after, but you're making a mess with the foam and the rinse water. They've used foam on something similar to this also.

(Patterson) - Let's say we put a layer of foam on this cable tray and it would run down through the cables, could we vacuum it up with the wet vac?

(Comment) - Yes, in your vacuum cleaner you would have to have a defoaming agent to knock the foam down.

(Patterson) - That way, you could limit the amount of volume you're talking about and limit the mess if you'd just vacuum it out of there. But, you'd have to take the trays apart and it's going to be a job.

(Matasa) - How about pouring something inside, like a rubbery material? Think in terms of a strippable coating--the same concept; pouring it inside, allowing it to solidify, pick up everything which is around and then remove it. If it is a rubbery material, you can do this. It will pick up everything inside and what's on the paint. You may get those cables clean and you will not have any spill around. It should be something that will be developed "ad hoc" for that particular type of use. I believe this material can be provided.

(Comment) - There's a lot of tie wraps every so many feet where so many cables are bound together. It's going to stick to the tie wraps.

(Matasa) - You'll have to work a little with it.

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(Patterson) - We must not neglect doses to personnel doing the work. If we had a method where the man would be right on these cable trays for long periods of time, the amount of man-rem's would be tremendous. We should think in terms of keeping dose level down. That's got to be kept in mind in all decontamination programs.

(Hall) - If you're going to destroy the wire, salvage it and not reuse it, you can make strategic cuts and at some cooler work space, or one that you prepare in advance, just pull them out of the cable tray and do what you want with it.

(Comment) - You might be able to take the trays and all with the methods you referred to.

(Matasa) - Solidify everything and just sever the trays and take the whole thing out in sections.

(Comment) - There's no need to solidify them unless you're afraid of spreading contamination. There again, you're just creating more weight. If you're going to cut them, section, and dispose them--just put them right in the container.

(Comment) - It depends on how badly they are contaminated.

(Hall) - With the coating, you could stack them somewhere for salvage at some later date and reduce that volume.

(Arrowsmith) - There is a class of fixatives that could be put on and then by placing them in a basic environment (say NaOH and H₂O) it'll dissolve the coating. With this method, it would be very easy to coat them, stack them, and at some later date remove the coating with an easy chemical step.

(Question) - Is there a possibility of making some type of box-shaped device that would hinge and clamp over the whole cable tray and would have a spray header on the top and bottom and clamp around the whole thing? This would then slide down between the hangers on the cable tray. Most of these are of similar size, so maybe two or three of those things--you would clamp over the thing. It's got flexible seals on both ends and a spray header on the top and bottom. You just spray and suck foam

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or some kind of cleaning solvent and just slip it down the length of the tray between hangers.

(Patterson) - It's possible that a lot of the tray is covered with a corrugated cover. I don't know if that's the case but it's very possible. They're not sealed; they have slots in them to let the heat out.

(Comments about safety-related removal of some covers after the Browns Ferry fire.)

(Hall) - Most of them are ventilated, if they have them at all.

(Patterson) - Let's get into some of the reactor system coolant components. I'd like to get into things like the pressurizer, which if we decontaminate the RCS with chemical the pressurizer will not see the chemicals. I'd like to get into the pressurizer, the control rod drive mechanisms and particularly the upper internals and possibly the lower internals. And possibly the reactor vessel head.

Control Rod Drive Mechanism

Let's start with the control rod drive mechanism. The CRDM sets on top of the reactor vessel and the control rod goes through the reactor vessel head. The CRDM does have a motor inside it. Is there a B&W person here who could explain this better than I can?

(Rogers) - The stator assembly is externally removed and can be handled separately and taken away. The rollers and rotor of the motor are inside the primary motor tube--when you're getting into that, you're getting into small clearances and very tight tolerances. Because these can be removed separately as an individual unit (69 on a head) and handled individually rather than all 69 at the same time. The part that fits on top of the head, is about 15 feet long so if you're going to put it into some type of wash tank assembly, it could be built ahead of time.

(Patterson) - We'd like to decontaminate those to the point where they could be reused.

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(Question) - What kind of dose rates are we talking about?

(Rogers) - At the time of the incident, all the noncondensable radioactive hot gases, at 700-some degrees are all up in that mechanized assembly. I'd consider that a condition that must be evaluated for capabilities for reuse because of that. We don't know what the hot gas annealing treatment has done to the steels, the mechanisms and the components themselves. That needs to be evaluated.

(Patterson) - Even if we don't reuse them we'd want to evaluate them, before you'd throw them away. In order to evaluate them, they should be decontaminated to very low levels.

(Rogers) - The rotor assembly can be removed from the primary motor tube assembly. That's going to be hot work if you don't decontaminate first. Because of the tolerances you've got in trying to get some kind of a cleaning fluid inside the full length of it, with the top of it open you could pass fluid through it. The flow rate is going to be so very minimal because of the tight tolerances where the roller nuts and the rotor assembly interface you're not going to get a very good flush. It would be a very slow flow rate that you could pass through it. A dip wash is about the best thing you can get out of it.

(Patterson) - The materials are basically stainless steel. We'd like to get it clean enough for inspection and evaluation for reuse.

(Question) - What kind of dose rates are you talking about?

(Patterson) - I think they're extremely high on top of that--probably in the thousands of rads range. They're going to have to be removed and they're going to have to be decontaminated.

(Question) - Are there any plans for making some kind of a bell or shield to pull these things into?

(Patterson) - There are a lot of things being done right now as to how to disassemble the reactor vessel and that's one major task in itself. Let's say we have the CRDM, now what do we do with it?

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(Hall) - You may want to have a vertical pipe with a liquid in it that you can dip it into and do some good before you move it far. Dip it for chemical decontamination.

(Patterson) - Chemical decontamination, if it doesn't have some kind of flow rate, isn't too good.

(Hall) - Move the assembly.

(Matasa) - Or, use a vibrator.

(Comment) - Ultrasonic should get all the loose stuff off. The problem is going to be removing a plating of fission product materials.

(Patterson) - How about ultrasonics for an initial step?

(Answer) - Well, I'm not impressed with ultrasonic. It barely gets the loose stuff off!

(Matasa) - We like to talk about ultrasonic but I believe that the normal network frequency of 50 cycles/min would suffice in many cases. Why should we go to ultrasonic; it's more active but far more expensive. There are special vibrators for such purposes (60 cycles/min) that may work as well without the use of ultrasonics.

(Arrowsmith) - I guess you'd expect most of the contamination to be on the outside of it for the same reason that small tolerances inside are going to restrict, at least, access to . . . the flow of material would be greater on the outer surfaces than on the inside. Maybe the first thing would be to clean the outside somehow.

(Hall) - Did you not have reactor atmosphere inside the thing?

(Arrowsmith) - You would have. You might have 1000 R/hr on the outside and 100 R/hr inside.

(Hall) - I would think it would be the other way around.

(Arrowsmith) - You think it comes up from the inside?

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(Patterson) - The CRDR would have seen the entire reactor coolant system atmosphere.

(Arrowsmith) - The transport mechanism might be a limiting factor.

(Comment) - I'm not sure that the mechanisms inside are still not water bathed. They've never been vented. The gases that have not condensed out are still in there.

(Arrowsmith) - As far as the baked on layer, we have some experience in removing those at Battelle. Even heavily oxidized stainless steel canisters such as they've used in the vitrification program, we found we could electropolish that and get those surfaces off and end up with noncontaminated surfaces. It's a destructive process so to speak. I guess the outer parts of it could be cleaned but I don't have a good answer for the insides. Those would have to be disassembled to get them clean, I would guess.

(Comment) - We may have to electropolish them just to be able to bury them.

(Arrowsmith) - You'd probably electropolish them just to reduce the levels to make transportation easier.

(Patterson) - By immersion electropolishing?

(Arrowsmith) - By either one. The pump stream techniques could do it. Since they're all roughly the same geometry, instead of having an immersion tank, you'd do it another way, maybe a combination of immersion and in situ techniques. But some way or another you could apply electropolishing to clean the outer surfaces.

(Patterson) - What kind of tolerances are they? What if you pumped a high pressure through there? Let's say hydrolaser type jets, 2000-5000 psi jets.

(Rogers) - If you take the rotor assembly out, then you've got a whole different cleaning capability. As long as the rotor assembly remains in that prior to decontamination, you've got the tight tolerances. Once that's out, you've got a multi surfaced type assembly.

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(Arrowsmith) - Once you get that, you can use these internal cathode arrangements and you could use immersion technology for the part you took out.

(Rogers) - The disassembly, or the decontamination to allow disassembly is the first step.

(Arrowsmith) - That's the trick.

(Allen) - I keep mentioning Freon, but it does have one other advantage and that's low viscosity which means it will flow very readily, even through small orifices. You may be able to pump Freon at a high flow rate even through fairly restricted openings.

(Comment) - In the reactor head removal operation or disassembly, to get anywhere, we may have to cut all 69 of these before we get . . . before we can even get the head off. That'll be prior to any serious decontamination effort.

(Arrowsmith) - If you really cut them off, you could take them off one at a time and decontaminate them right there, as a preliminary step to get it from high levels. Electropolishing baths like that wouldn't be very sophisticated. They'd be nothing more than a trough. In fact, Jim, aren't they doing something like that at Dresden on control rod drives? What were the experiences there?

(Testa) - I'm not sure; I haven't been home long enough to find out.

(Arrowsmith) - I know a little about it and they are electropolishing the control rod drive mechanisms and the interesting part was the first time they tried to electropolish (they're nitrated surfaces to harden them, aren't they) them, it was successful. Those are going to be reused on the reactors.

(Patterson) - Who could we contact for that information, Jim? We'd appreciate it if you could get that for us. It might be very helpful.

(Testa) - I'll get it for you--I'm going home tomorrow.

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(Hall) - You might have to flood the cavity and cut the things under water in order to get them sectioned to take them out a piece at a time.

(Patterson) - Disassembly is one major field that we don't want to get into today.

(Hall) - But you may have to consider that in order to do the decontamination you're talking about.

(Patterson) - That's a consideration to flood the cavity.

(Arrowsmith) - I think it would be possible to actually electropolish something while it was immersed under water by using these in situ devices that are closely fitting. You'd slowly contaminate the water with acid but you could, using an in situ device that's going down the inside of something and making an effort to contain the acid, do that with heavy shielding--deep water. The acid would be allowed to escape into the water but rather than starting out with a high electropolishing bath, you could start out with a pool of water. You'd make an effort to seal. Some of those things we've built do recirculate electrolyte without allowing it to leak out. You could do the same thing. If you're talking about 1000 R/hr field, you have to do something. Fill that cavity with water, cut it off, and do some preliminary decontamination under water.

(Hall) - That might be the only way.

(Matasa) - How do electropolishing and scrubbing with chemicals compare for normal metal surfaces?

(Arrowsmith) - Electropolishing is far superior to chemicals. The problem with most chemicals is you have a real problem with recontamination. With electropolishing, we've succeeded in avoiding that. We don't know why. Using phosphoric acid, we don't have something we can prove but it's true.

(Patterson) - Pressurizer; (also relevant to other tanks). It's basically a giant vessel. It's about 50 feet high and 8-10 feet in diameter. Probably highly contaminated from the accident.

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(Comment) - Stainless steel bonded inside and carbon steel outside. It was shipped here with typical high temperature aluminum protective paint that flakes and peels off during normal operation. There's probably not much of a painted surface left on the outside. Stainless on the inside.

(Patterson) - The big problem will be on the inside. It saw a very high temperature environment with all the high fission product gases and is probably highly contaminated inside.

(Question) - Is it stitch clad inside?

(Patterson) - It's a welded bond, stainless steel inside. It's a large vessel and you wouldn't want to send anybody inside and start scrubbing.

(Comment) - The pressurizer should be treated in no worse condition than the majority of the rest of the RCS.

(Patterson) - Some of the ideas for the RCS itself might be chemical cleaning, running the reactor coolant pumps and flushing, and that sort of thing. The pressurizer itself sets off and would not be touched by any kind of flush that you would do with the coolant system. (Refers to diagram showing pumps and piping, steam generator.) It's a closed loop system where we can use chemicals or pumping techniques with the reactor coolant pump to get the system clean. But what I'd like to discuss today is the pressurizer. No matter what you do, it's not really part of this closed loop, in that a pipe will come off this pipe and go to a pressurizer, which is essentially at a higher elevation than the loop. The pressurizer sets on top of the loop to provide an over pressure for the RCS.

(Question) - Where's the spray flow coming from? Essentially you could make that part of the closed loop by using the spray.

(Patterson) - There is a line, and that's a good point, that comes into the top of the pressurizer. I don't know what size it is, say 4-6 in., that from the reactor coolant pumps provides a spray to the top of the pressurizer. But it's not a large spray line. This is used essentially to control the pressure in the pressurizer during normal operation.

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(Hall) - Usually these pressurizer sprays are more like a rain than a flushing. Under solid water conditions, though, you're pumping water. The pressurizer spray nozzle is designed so that the spray doesn't hit the vessel itself; it collapses the steam bubble.

(Patterson) - The only thing you could do would be get a small flow going through this vessel.

(Arrowsmith) - That would be done, though, I would assume as a first step because it's relatively easy to do.

(Patterson) - If you chemically decontaminate the whole system?

(Arrowsmith) - Even if you were just recirculating water. Is there going to be fuel debris in there possibly from the gurgling and splashing around that might have occurred?

(Patterson) - One thought is to have this as part of the system to try to get some of it, but I don't think we're going to get any velocity at all.

(Comment) - Sprays drive off the core differential pressure. If you get the thing open, you can artificially increase the differential pressure and increase the flow in the solid water condition. Assuming you're going to take the core out late in the game, you can get very high solid water velocities through there by plugging up the inlet line from the main coolant pump late in the game. Even so, we still don't have the pipes and the size of the line you need coming in.

(Arrowsmith) - It just seems like a first step. Let's say we washed it out with water or chemicals and we still have some left.

(Patterson) - If we used chemical for the whole system that might do the job. Chemicals depend on temperature.

(Arrowsmith) - . . . another way to do it is to fill it with very dilute electrolyte. We've done work with mixes as dilute as 10% and have been able to do it. But there's probably a way to do that. You'd have to look at the geometry. I'd think you'd

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want to do a flush as well as you could, use hydrolasers and whatever, and then, when you get to the point where nothing is coming off because it's baked on or strongly attached, then you'd be forced to use a very strong chemical or electropolishing.

(Question) - Other than the accident, what's the normal dose rate on this piece of equipment?

(Patterson) - We've designed it for over a hundred mR/hr.

(Comment) - Ours runs about 25 mR/hr.

(Arrowsmith) - One would have to guess that the pressurizer is not going to be the biggest problem. There are probably a number of ways to do it. How practical is chemical decontamination? Are we going to be able to do that?

(Patterson) - I'm not sure how practical it is. I just know of all the trouble they've had selling it as Dresden. They started that program in 1972, and they're still working on the chemical decontamination of Dresden.

(Testa) - Our problem at Dresden now is getting the pipes put together; we've had problems getting welders, etc. We're going to decon in April. As far as licensing, materials, etc., there's no problem.

(Patterson) - It still took time to get that license.

(Patterson) - The Canadian decontamination process that was discussed yesterday by Paul Pettit, the use of demineralizers and low concentrations of chemicals is possibly one way to go to minimize the amount of chemicals you have to process. Chemical decontamination of this whole system is a definite possibility, at least with the fuel out - I'm not sure with the fuel in.

(Question) - Is it likely that fission products from the accident are plated out on the walls?

(Patterson) - I think it's very likely.

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(Question) - Soluble?

(Patterson) - It saw pretty high temperatures. I would hope it would be soluble but due to the high temperatures, some won't wash off with straight water.

(Hall) - What were the maximum temperatures in the containment?

(Patterson) - Not too high - about 180 and maybe some localized areas that were hotter than that - but in general about 180. The pressurizer wall saw very high temperatures; it normally sees high temperatures and in this case they were even higher. It's about 50-100° higher than the main coolant system.

(Arrowsmith) - It's probably not the temperature alone that will affect it, it's what was there during the accident. What kind of gases were floating around and what plated out on the walls.

(Patterson) - We hope to have those answers as soon as we can get some samples of the piping, steam generator tubes, etc.

(Matasa) - Does anyone know if there is any difference in the half life if it is kept at a lower temperature?

(Patterson) - Shouldn't have any effect at all.

Other Items of Concern

(Patterson) - Once the reactor vessel head is off, we'll want to do a detailed inspection of the head to see if it's reusable. Our first thought was hydrolase it but then a lot of people have told us that they've tried to hydrolase a head and it hasn't worked. They've gotten poor decontamination factors. I'm looking for something other than a hydrolaser or comment on using a hydrolaser to clean the inside and the outside of the reactor vessel head. The reactor vessel head is basically carbon steel with stainless steel cladding on the inside. Any comment on the use of hydrolasers for the head?

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(Gutshall) - We've hydrolased heads at Peach Bottom and had good results. Not clean but down within workable ranges. From several rads down to 60-70,000 c/m.

(Comment) - Gets rid of most of the smearables.

(Patterson) - This is my first thought, but some of the people I've talked to indicated that they've had lousy times and didn't recommend hydrolasers.

(Question) - Could the problem have been the CRDM's that are usually left up on top of the head that are crud traps?

(Patterson) - Possibly.

(Question) - Do they have a reactor vessel head laydown area?

(Patterson) - Yes.

(Comment) - One thing with hydrolasers, it's the people who use them. Not everyone uses a hydrolaser properly, and if not used properly, you won't get the desired results.

(Arrowsmith) - That's a general statement, too, with all the decontamination techniques. You can read the book and go and try it, or find someone who knows how to do it. Sometimes reading the book is not enough.

(Patterson) - Any other thoughts besides hydrolasers?

(Comment) - Chemical cleaning, put it in a bath as mentioned.

(Arrowsmith) - I would probably use the hydrolaser and get it as clean as you can, then, if necessary, use an in situ electropolishing technique. There's no doubt that you could get it as clean as you wanted it with an in situ electropolishing technique. Unless you have a place big enough that would house a tank big enough to hold the whole thing, I believe I'd use one of these swab techniques. You could circulate the acid through a swab arrangement, decon an area and then move to another area.

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(Question) - Is there any problem in electropolishing with thickness of the metal itself?

(Arrowsmith) - Not generally. We remove so little. You don't want to thin the clad down to where it's below tolerance, though. But we're only talking about a few mils. You don't particularly care if that's completely clean.

(Patterson) - We want it pretty clean because we don't want a high dosage rate when we do a detailed inservice inspection.

(Arrowsmith) - With electropolishing you can get it as clean as you want it, as long as you're willing to expend the metal removal to do it. You'll have to make that choice. If you wanted to make it clean enough to "take it out the door" you probably could do it with electropolishing and a lot of time. You could choose to stop somewhere else, where you could carry out your inspection. My view of the component and other components like it is that you'd wash off using normal techniques and then take it down further with electropolishing.

(Patterson) - Have a comment, John?

(Remark) - Are you not going to remove the head, remove the fuel, put the head back on, and chemically clean your system?

(Patterson) - That's further down the line. We want to check out the head very early in the game. As soon as we remove that head, we want to decontaminate it and inspect it. If we do RCS decontamination by chemicals, it would be many months after head removal. In fact, it would be about a year after the head was off before we'd go in and do any kind of decontamination work in the RCS.

(Hall) - Are you primarily concerned with the inside cleanliness to start with?

(Patterson) - Outside and inside. A detailed inspection would be done well before RCS decontamination.

(Question) - You plan to reuse the head?

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(Patterson) - Yes, we'd like to reuse the head. Right now, I haven't heard any indications for not trying to reuse it.

(Comment) - Are you going to verify its integrity before you start doing a lot of decontamination work on it?

(Patterson) - Yes, there's a large time frame between the time we take the head off and the time we do a major RCS decon. We don't want to lose that large time frame. We could lose a year. But if we got to the head early and inspected it early, we could have it inspected and, if there is a problem with it, we could have another one on order.

(Question) - Is electropolishing a function of surface area? Could you do the head all at once?

(Arrowsmith) - When we're dealing with components we want to reuse, we want to operate at a reasonable current density range. That means you're going to use maybe 100-150 A/sq. ft. For that reason, you wouldn't do the whole head at one time, but you could put it in a tank. Instead of making a cathode visible to the whole head at one time, you could make it visible to one-fourth of it, or whatever.

(Comment) - I was thinking of putting a seal down on the reactor vessel head lay-down area and just filling up the inside of it and doing it at that point, but you've got about a 12 or 13 ft diameter head, a hemisphere.

(Arrowsmith) - That's not really so big. The commercial electropolishing industry, Coors Beer, for example, routinely electropolishes 4 x 10 ft stainless steel sheets. They do that every day. If you had a real need to electropolish the whole head at one time, it is technically feasible to do it.

(Comment) - Once you lay that down, you could set it up and walk away from it. You wouldn't have to get in there and do it manually.

(Arrowsmith) - And you wouldn't have to do it with the in situ techniques, either. You could do it from a long distance or even under water. I think some of the in situ techniques could be made to operate under a water shield if you had to.

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(Matasa) - What is the biggest surface you have done at once with in situ?

(Arrowsmith) - The largest in situ device we've built did a 2-ft-diameter circle but that's just because that was as large as we intended to do. You could make it as large as you want. The first thing you'd like to know is how long would it take to decontaminate it. In the 5000 gal tank, it was better for us to use the smaller device of only a couple sq. ft at a time because we could move so rapidly; only 5 second resident time/area. We didn't need a huge device. Therefore, we had small leads, small everything, and a very neat way of doing it.

(Question) - What's your normal metal removal rate?

(Arrowsmith) - That's important, especially when talking about clad material. Our experience has been, if that surface was reasonable to begin with,

(Question) - What do you mean by reasonable?

(Arrowsmith) - If you're asking what would be the maximum that we would have to take off, the "grossest" things we worked on at Battelle, where we had to take off a lot of material, was 1-2 mils to get it clean. A lot of our work, though, is maybe .1-.2 mils. The Navy sent us some parts to a steam valve out of a sub (which had been carefully measured) and we did it and returned the parts to them. The amount of material we had removed was too small to measure with their devices. They couldn't tell if we had or not. We have quite a bit of history to give you some idea of what could be done. Again, you're substituting metal removal for achieving lower and lower decontamination rates. (Illustrates fact that sufficient decontamination for exposure reduction applications can generally be obtained by removing less than 1 mil of metal, but the removal of 1-2 mils may be required for decontamination to background.)

(Question) - What would be so bad about converting the laydown area to a canal type situation and rigging it up as a permanent thing and decontaminate everything in there and then remove things and place them in the facility you were talking about?

(Arrowsmith) - Could well do that. What's the size of that pit? Is it a pit?

(Comment) - Not yet, but we could make it into a pit.

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(Arrowsmith) - My own view of this is electropolishing is going to be useful in some places, but if I could do it with the hydrolaser rather than electropolishing, I'd probably do it that way because all you'd have to do is process the water. There just has to be a balance of common sense. You use the electropolish when you can't do it another way.

(Patterson) - The upper internals: Let's turn to the upper internals in the reactor coolant system. Again, there's discussion on whether they'd be saved or discarded. We want to inspect them early and decontaminate if we can, thoroughly, as soon as it comes out of the reactor vessel. We want to determine whether it will be saved.

(Arrowsmith) - Could those components be done in the same area as the head?

(Patterson) - Probably so. Mr. Rogers, will you talk about the upper internals?

(Rogers) - The upper internals assembly is that device which holds the top of the fuel assemblies together. It has 69 guide tubes through it for the control rods to be parked in when they're withdrawn from the fuel assembly for normal operation. It has 8 other tube assemblies through it which were originally intended for γ -valve temperature monitoring. It's really a cork with a lot of holes in it. It's all stainless steel construction. It's about 18 ft high. If you take all the control rod drive assemblies out of the head, it's really not a tall device.

(Question) - How much is subject to neutron activation due to operation?

(Rogers) - Only the lower part of it is; it sits on top of the fuel assembly. Only the first few inches of the thing as it sets on top of the fuel. The rest is all fission product contamination and crud contamination. Typically in an operating plant, as we remove the upper internals, the top of the bottom assembly usually has about 1-2 R/hr and about 10-15 R/hr at the bottom. That is relative only to an operating plant.

(Arrowsmith) - What percentage of the 10-15 R/hr at the bottom is crud as compared to activation?

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(Rogers) - The crud levels would be about the same from the top to the bottom. Approximately 1-2 R/hr of the 10-15 R/hr. The clearances in the guide tube are not critical, so here's a case where electropolishing would be attractive.

(Question) - Can you do electropolishing on something of that configuration?

(Arrowsmith) - Yes. You have these internal cathode arrangements we talked about.

(Matasa) - Part by part?

(Arrowsmith) - You might do several tubes at once.

(Patterson) - You'd put the cathode down the guide tube?

(Arrowsmith) - Yes, down the guide tube.

(Rogers) - The guide tubes are not a tube assembly - it's "C" shaped. There are 16 of these in each one of the 69 assemblies for the control rod mechanism. There's a spider assembly for each one of the control rods themselves. They have to go through the open "C" on the guide tube. That tube is not a closed assembly. All surfaces in there are machined surfaces except for the "C" tube assembly.

(Arrowsmith) - That wouldn't be a problem. For example, one of the pipes we just did for the Navy was a 4 in. line, a diffuser pipe, that went through the center of their tank. They perforated the bottom of it with many holes and we couldn't fill the pipe. What we did was we made a device we were able to pump electrolyte in it fast enough so it locally filled the cathode-anode spacing and we just slid it along. Of course, the acid was leaking out at a reasonable rate but that was okay because we'd accomplished the job of filling the annulus. We were just recirculating so we'd expect the acid in this case to be picked up and reused.

(Rogers) - Normally, in a refueling operation, the internals are removed before the transfer canal is flooded. They're taken out of the vessel and stored so that we can go down and do additional work around the flange before the refueling canal is flooded. In this case, with the fission product activity, I don't think we can even address that

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sort of thing. It's going to come out under water and it'll probably have to be stored under water until significant decontamination is done.

(Patterson) - What would you do Bud? Put it in a big tank of electrolyte?

(Arrowsmith) - You'd probably try to do it piece by piece. If you're just trying to decontaminate those pipes . . . how close is the next one? You really have two operations here. One is, we have to make an arrangement that goes down the outside and does that and it'll be just as contaminated.

(Rogers) - Well, you don't have the accessibility, though, to get at those easily.

(Arrowsmith) - You're going to have to do that with pumped stream. It's reasonable to make an internal cathode arrangement to do this job. You have an irregular surface with bumps and protrusions, so you can't use conforming cathodes, then you can use these pumped stream techniques that are simply pumping a stream of electrolyte at that and actually electropolishing the area right there. It's a slow process but it can be done, if you can't do it any other way. Again, you'd hope you can wash it off or do it some other way.

(Question) - What is the electrolyte again, Bud?

(Arrowsmith) - We're using phosphoric acid. There are many electrolyte compositions available. Commercial electropolishing solutions are normally phosphoric-sulfuric. The reason we're sticking with phosphoric only is that it's a very nice actor in terms of acids. We don't have to worry about many of the problems associated with other acids.

We just have to engineer our way through it to see if we really could do it. We should keep in mind when engineering any system, we said that this would normally be 15 R/hr field. This piece of equipment will probably reach 4000 R/hr beta. When you start designing the system, you must process that acid, or whatever it might be, and you're really creating a monster.

(Arrowsmith) - The nice thing about beta, is that it'll be shielded out by the liquid itself to a great extent.

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(Comment) - But we found that by putting shield on, we're getting x-rays.

(Arrowsmith) - You have to process, there's no doubt about that. That's really the argument for making a big tank and keeping the things you're working with under the acid you're working with, even if you're doing it by in situ. You may well want to put it in that just for shielding.

(Comments on high levels from small samples) You can imagine what a large surface is going to be like.

(Arrowsmith) - This is going to be a test of everyone's ingenuity. We can't finalize anything here.

People in attendance at session:

T. M. Patterson, Bechtel Power Corporation
R. R. Smith, Argonne West
Gary Bethke, Detroit Edison
Bob Holtzworth, EG&G Idaho
Claude Matasa, Imperial Technical Center
Tom Hall, UNC Nuclear Industries at Richland, Washington
Edward Taylor, Argonne East
Charles Bishop, NRC
Lee Rogers, B&W Site Management
John Remark, B&W Site Management
Bill Davis, Mound Laboratory, Monsanto, California
Jim Testa, Commonwealth Edison, GPU
R. L. Russell, Portland General Electric
L. A. Pember, HEDL
W. J. Tearney, Catalytic Inc., Philadelphia, Pennsylvania
Don Knowlton, Battelle-Northwest, Richland, Washington
Jim Otelka, Argonne East
J. J. Gutshall, Pennsylvania Power and Light
R. R. King, Battelle-Northwest, Richland, Washington
Harry Collins, Atomic Energy Agency, Ontario
Val Bouchard, Vichem

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Richard Allen, Battelle-Northwest, Richland, Washington

H. W. (Bud) Arrowsmith, Battelle-Northwest, Richland, Washington

Earl Wheelwright, Battelle-Northwest, Richland, Washington

DECONTAMINATION WASTE MANAGEMENT TECHNIQUES WORKSHOP

DISCUSSION LEADER - TOM MORRIS (BECHTEL)

Discussion Session on
Decontamination Waste Management Techniques Workshop
November 29, 1979
Discussion Leader - Tom Morris (Bechtel)

(Discussion Leader) - Good afternoon. My name is Tom Morris. I'm from Bechtel Power Corporation, Gaithersburg, Maryland. My current position is Nuclear Licensing Group Supervisor for the TMI Project. The topic for this afternoon is decontamination waste management.

I would like to start off by summarizing the TMI-2 problem, if I can, and then to lead off with a couple of questions for the group. First, what we're really talking about is radwaste. I'd like to make sure our discussion centers on how we're going to process this radwaste after we get it out of the containment building. Quite obviously what we generate and have to process will be influenced by the decon methods we select and there's a lot of possibilities still under consideration. We addressed some of these in this morning's discussions including how we might move washdown solutions from upper levels to lower levels and out of the building. Now we also want to consider how we can process the radwaste, how we might store it, and how we can dispose of it once we complete processing and have the waste in solid form.

When I started trying to figure out an outline for this discussion, I was thinking exclusively in terms of how to process the waste and get it off the site but there is another part of the problem on which I believe a lot of you have a lot of experience and that is what I would term local decon radwaste management. Where we have a specific area that's contaminated, how do we manage the cleanup so it doesn't become a more general problem elsewhere in the containment? We want to address the overall management of radwaste from the containment building and local decon waste management within the containment building as we try to proceed with plant recovery.

One other thing I'd like to go through is a summation of the factors we have to consider in trying to define a decon program. First, we have both surface contamination and contaminated liquids in the reactor building. We have about 530,000 gallons of water in the sump that we're going to have to process and we're going to have to store the resulting radwaste until we have a solidification means. Then we're

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going to have to solidify it and get permission to dispose of it. We have a lot of surface contamination in the containment building but we're not really sure by what mechanisms it has attached itself to the surfaces or just how best to get it from where it is into controllable, removable, processable form and out of the containment.

In addition, we have a lot of outside influences affecting things. We have assessments to go through; we have disposal licensing criteria to consider, both in terms of temporary staging at TMI and ultimate disposal when we've finished the cleanup; we have cost and schedule influences; we have to do things in short order that quite possibly we could do better if we had more time; and we have some outside influences in terms of intervention. An awful lot of decisions will not be made on strictly technical bases. Instead, they'll be made in a political or licensing kind of arena which doesn't allow us all the time to predict what the appropriate answers should be. All of our decon decisions will have a lot of factors influencing them. I'm sure in the discussions you will start to appreciate some of the influences impacting what we're trying to do and where we're trying to go--why we can't always localize a problem and come up with a solution without ten or twenty other things influencing the ultimate decision.

With that, I don't have a discussion outline for us to follow other than just talking about overall waste management to see if that will generate some conversation. Possibly the best way to start is to ask if there are any general questions about where we think we're going and let everybody talk to that. Are there any questions from the group?

(Question) - Which of the alternative surface decon methods are under active consideration by Bechtel?

(Discussion Leader) - Right now we're going through a radwaste management scoping study in which we're trying to "envelop" the quantities of radwaste, both solid form and liquid form, and we're trying to envelop the amount of water we think is going to be used during decon so we can make sure that the systems being designed and put in place right now are properly sized. A lot of alternative decon methods are being considered, for example: remotely spraying down with deionized water;

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going into the containment and spraying with deionized water; Radiac wash; hands-on scrubbing; strippable coatings; anything we can think of in terms of surface contamination removal and processing. I don't think we've yet covered all the possible ways we might generate wastes.

(Question) - Which way do people think they can dispose of all the processed radwaste? What kind of solidification means do you have in mind?

(Discussion Leader) - The Dow process is being looked at right now. A lot of the potential solidification methods are affected by the waste processing scheme used and by the chemicals that may be utilized for decon in the containment. Many such things, once we put them into the decon stream if I can call it that, limit our ability to process through a demineralizer bed, for example. We might have to go to an evaporator to concentrate the radwaste for solidification or packaging because some constituent would not allow the other system to collect and retain the radioactivity. In general, we're thinking of conventional methods for solidifying the processed wastes. Everything is going to have to go out in solid form. Right now one of our key constraints is no liquid discharge.

(Question) - How about compacted?

(Discussion Leader) - We are looking at incineration in terms of volume reduction for paper towels, other combustibles, whatever we can.

(Question) - Do you have a solidification unit right now?

(Discussion Leader) - No.

(Question) - Are you planning to buy one?

(Discussion Leader) - Yes.

(Comment) - I have read communications which show that tritium is found in the form of gas, not in water.

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(Discussion Leader) - In our case essentially all the tritium present is in the form of tritiated water which gives us another problem because no processing scheme applicable to our radwaste that I know of can separate the tritium so that the treated water can be considered tritium-free. However, there are other options we're studying right now such as reuse after extended onsite storage. We have approximately a million gallons of water at from 0.1 $\mu\text{Ci/ml}$ to 1.0 $\mu\text{Ci/ml}$ tritium activity. We would like, if we could, to process it through the radwaste treatment systems that we currently envision on the island and then store it in a one-acre pond about 3 or 4 feet deep. Some tritium would be released by evaporation but that's done all the time anyway--every spent fuel pool releases some tritium. It's one of the alternatives we've been looking at with the ultimate expectation that the water could be used again. For example, when we're going to use the spent fuel pool again, we could put the stored water through the demineralizer and fill the pool with it. It would still have tritium in it but that wouldn't matter there.

(Question) - Earlier this morning we were talking about the SDS (submerged demineralizer system)--where does it get that designation?

(Discussion Leader) - That system is being designed and engineered to be located in the spent fuel pool. It's supposed to be submerged for shielding. It will be used to process the containment sump water which contains about 180 $\mu\text{Ci/ml}$ cesium. The SDS was originally envisioned as taking as much activity out of the sump water as it could in one pass to produce pretty clean water, except for the tritium. However, the water in the sump is not our normal water. There's indication of a gelatinous texture, some amount of crud and/or precipitates in it, such that it cannot be assumed to be processable in the normal manner. Certain species of cesium apparently are not behaving properly. The concentrations of these things are very low but they are influencing the DFs we thought we could get from that system. It's due to be in place and functioning sometime around the end of 1980.

(Question) - How will the loaded resins be treated?

(Discussion Leader) - We have yet to figure out how to solidify these things. We have indications that at least low level waste is being relooked at in terms of

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isotopic concentrations. When the problem was first considered, GPU thought they would be able to dewater the resins and then ship them without further treatment but that is no longer an option. We've been told by NRC that everything coming off TMI in terms of loaded resins will have to be solidified, which wasn't part of the original design basis. That is a problem with Epicore 2 right now. The liners in which the loaded resin is contained have enough baffles in them that you can't just pour a solidification agent in and expect the entire volume to set up which means that we're going to have to take the liners out of the temporary staging facility you heard described and dump the contents into another container for solidification.

(Comment) - At least you have time to design the SDS primary resin container to permit solidification.

(Question) - Have you considered long term storage of the processed waste at TMI--let's say for the entire life of the plant?

(Discussion Leader) - I'm not sure what you mean by the entire life of the plant but we have considered onsite storage for longer than was originally envisioned. We don't think it would be easy to license ultimate disposal here but we haven't started to consider the environmental impact of shipping larger quantities of radwaste from the site than were in the original assessment for the plant. One of the options we were asked to look at was a gross decon of the containment sump water by flushing it through an ion exchange system and then storing the loaded resins some place on the site without solidifying them. From a technical aspect it could be done but I doubt that we would be allowed to leave thousands of curies on the resins for any great length of time without solidification.

(Question) - When NRC told you that you couldn't ship dewatered resin, did they say what form it would have to be in before it could be shipped? Don't we need a specification of acceptable solid form as a function of activity density, or something like that? Otherwise you don't really know where to start.

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(Discussion Leader) - That is true. There are a lot of "unspecified criteria" we're trying to second guess right now. I have to agree that we don't know what is going to be acceptable.

(Question) - Have you considered what is going to happen as the resin is decomposed by the radiation that is on it? How about the gases that are produced when the organic resin decomposes?

(Response) - The Submerged Demineralizer System does not use an organic resin. It uses a zeolite. The reason zeolite was selected was because of potential radiation damage. There is sufficient development work available to indicate that zeolite is compatible with concrete. You don't have radiolytic gas formation.

(Question) - What about the resins already loaded from the Epicore 2 system?

(Response) - Epicore 2 is used for processing water of activity level up to 100 $\mu\text{Ci/ml}$. It is not approved for activity levels like those of the sump water. The organic resins in Epicore 2 are being loaded to a limit of 1300 Ci/liner. Past experience has shown that organic resins can withstand up to about 10^8 rads accumulated exposure at which point you may get a gelatinous mass from which some species are no longer desorbable. You get no significant gassing at lower levels than that.

(Comment) - It looks like you have about three choices: resin, cement, or glass. That's the extent of available technology in this country. In selecting from among these three, glass is one you could use for everything (i.e., all types of radwaste you have to solidify); cement is the one you probably could use for most things; and resin is the one with the most restrictions. If you're looking for just one solidification process and you don't know what you'll find at the bottom of the sump, then glass may be the best choice. If you don't think you're going to find anything in the sump other than what you've already seen, then maybe some form of concrete will do. But you're down to just three choices, I think.

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(Comment) - Looking at these solidification methods, note that some are more susceptible to various pH's than others. If you have a great deal of decontamination solution to process, acids in particular, you might avoid a lot of the volume that would be required to pH-adjust by selecting a solidification method which will work with acidic wastes. In particular, cements usually require fairly neutral solutions and therefore you have a lot of pH adjustment to do and a lot of additional waste volume that's created when the clean caustic is added.

(Comment) - It may be a mundane thing but the onsite waste storage area I have seen on the drawings is placed right in the middle of a nice large area in such a way that a waste processing facility could not be placed alongside it. I strongly suggest that GPU take a look at how they are locating the storage areas because by moving two of them they could make room for a processing facility right alongside which could save a fair amount of money on transportation and handling.

(Comment) - At the Battelle Labs in the State of Washington we have come up with a system to utilize glass for waste solidification. Initial development was for high level waste fixation but the process can be used with any type of waste. The last 4 or 5 months we've processed radioactive hospital waste which is basically paper and plastic. In the last two months we've also had resin to solidify, basically organic resins. We turned them to ash and vitrified the results. We haven't tested inorganic resins and we haven't tested all the decon solutions but we really think it is a viable way for solidification of basically all types of waste: liquid, paper, plastic, etc.

(Comment) - We have, out in Idaho, taken a look at the zeolites and you can also put them into glass, if that's the form that would be acceptable.

(Comment) - The calciner/in-can melter system should be able to take care of any and all waste you have here at TMI, or at any other utility, for that matter.

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(Comment) - The facility would have to be located at TMI.

(Question) - What are the economics of something like this? GPU is going to be influenced by acceptability and licensability but they're also going to be influenced by dollars.

(Comment) - That's where volume reduction comes in. We have to factor that in to get a meaningful index of cost.

(Question) - How long does it take to get a facility of this type in place and functioning?

(Comment) - We have a system we put in our hot cells at Battelle which went in last month. Once we got the design, it took us about four months to get it fabricated--that's under normal fabrication time schedules--no big urgency on it. This was a small unit. You probably would need a bigger one for TMI but all the technology and all the designs are well known--pieces of equipment that have been used out there. It's just a matter of scaling to whatever size you want. We have systems now that have been used for a 3 ton per day reprocessing plant so we have anything you want from a small experimental unit to a production-size system.

(Question) - The 3 tons/day, is it 3 tons of waste or 3 tons of product?

(Comment) - It's 3 tons/day of uranium-equivalent waste; that is, high-level waste from reprocessing 3 tons of irradiated uranium fuel. It is a measure of the amount of waste going into the solidification plant.

(Comment) - You want to be careful about stating input capability because if you get very much of the chlorides in there the offgas system will not function at quite that rate.

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(Question) - What was your normal offgas level in terms of radioactivity?

(Comment) - We have fairly standard offgas treatment. In the last major project we took six bundles of fuel from Point Beach and processed them through to vitrification of the high-level waste and our system met all environmental and pollution control requirements. It was MPC at the stack.

(Comment) - But they won't let us vent the krypton from the containment even knowing it would be an order of magnitude less than MPC. This is a different organization at a different location. You really have to take a look at it from here. The cleanup, for example, on the waste calciner at INEL which burns kerosene and operates at 500°C is a scrub system and the treated offgas is released in the same way as at BNWL and at Idaho we also put out a substantial amount of krypton when there is processing of the Navy fuels but that is not the life you live at TMI. The environmental practices permitted here will not be the same as out there.

(Comment) - You really ought to begin investigating what will be accepted at TMI. We all ought to be concerned. We're going to have to be real insistent that what will be acceptable here gets defined, or at least the mechanisms by which acceptability will be determined get defined. It isn't going to be on the basis of limits on the measurable environmental impact, we know, because it can be shown that there is no such environmental impact using any of these systems. The point is that you must know ahead of time what the regulatory agencies will accept; what waste forms, what offgas releases, etc., in order to select and implement a system to handle the needs here at TMI because, if you have to develop a series of proposals and run them up the flagpole to see which one they salute, you're never going to make it. You may think it's reveille but it will turn out to be taps.

(Comment) - There are methods of analysis already established and ANS came up with some propositions at the San Francisco meeting too but, indeed, NRC has to define exactly what must be considered.

(Comment) - There is another possibility that would defer having to make a decision, at least on the resin solidification process, until you know what you're

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faced with. If you use the zeolite that's being proposed, you could slurry it off and store it "undewatered" in a waste tank. It wouldn't be too large--something like 1500 gallons of zeolite will be required so an even bigger tank would be practical. If you built a double-containment tank and buried it, you'd have a temporary storage system that would let you take your time in looking at the waste and deciding what solidification system is best for it. See what system is acceptable from a licensing point of view and then put that system in and work the waste off. It would give you the flexibility of not having to worry about how to get rid of the waste while you're in such a big hurry to get the decontamination program underway.

(Discussion Leader) - You've hit on a very important point. In a lot of cases we're rushing to do things and in other cases we are trying to weigh various alternatives. Not everything has to be processed immediately and a total system doesn't have to be in place immediately but we do have to find an acceptable stopping point. Maybe a double-lined 1500 gallon tank buried somewhere on the island would be acceptable and maybe it would not.

(Comment) - It could even be above ground. We haven't used that practice much in this country but there's nothing to having a concrete vault above ground--providing protection through overdesign.

(Discussion Leader) - One of the considerations is that we're talking about a horrendous amount of curies on those resins.

(Comment) - Not really--not by radiological standards. Let me tell you of some past experience with zeolite. Several years ago during the special nuclear systems program when we were making space sources, we routinely shipped packages containing on the order of 30 gallons of zeolite resin holding 400,000 Ci on that one bed, from Richland, Washington to Oak Ridge, Tennessee. As a matter of fact, when you go back 17 years, we had environmentally safe containers which had DOT and AEC approval for such shipments.

(Discussion Leader) - But we're dealing with political acceptability, not environmental safety.

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(Comment) - It still is important to note that the curies you have to deal with are not all that horrendous and that the technology for handling them is there. Admittedly, the cesium was not at a very high concentration in those shipments--that's a function of the kinetics--compared to what you would get from the 176 $\mu\text{Ci/ml}$ in the TMI-2 sump water.

(Discussion Leader) - Okay, but my point is that here there are an awful lot of outside influences that are not going to allow us to use what we might consider technically acceptable alternatives.

(Comment) - That point already has been made.

(Comment) - That shouldn't keep you from making the best technical proposal you can.

(Discussion Leader) - We're going to try to do that, but you have to understand that a 1500 gallon tank with a double liner may be big enough and safe enough to hold all the zeolites we're going to load in processing the sump water but the other consideration is that we're going to have to go through some licensing mechanism which says it's safe for the entire time it's there and part of that safe may be the ability to withstand an airplane crash.

(Comment) - I think these ideas are very good because they end up as more alternatives for consideration. I think they really ought all to be factored in. Technically you can do it. Politically, it may be more of a problem. As has been said, a lot of us feel that you have to go ahead and propose the technically sound solutions to get them out for discussion.

(Discussion Leader) - We intend to do that but I don't want everyone to think that just because something is technically feasible we're going to be allowed to do it.

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(Comment) - I think everyone understands that.

(Question) - Right now you have the capability to acquire small samples of water down through one penetration. How near in the future are you looking at drawing larger samples and are you looking at going through different penetrations for getting samples from different areas of the bottom?

(Discussion Leader) - I'm going to defer on that.

(Response) - We recognized early on that we needed some ion exchange and zeolite tests to determine which particular sorbent is best for the primary system water. We ascertained that zeolite was the best. We ran what are called KDs which just tell us which sorbent is better than the other. This is a kinetics business, however, and you need large volumes of water for definitive determinations. It's my understanding that there's been about 3 liters of water collected from the lower penetration for shipment to Oak Ridge where those studies will be made.

(Question) - Will the information be sent to other sources that are trying to be helpful on this problem?

(Response) - GPU recognizes that this work has to be done and they are paying for it. Although it will belong to them, I'm sure it will be made available to others.

(Discussion Leader) - I haven't seen too many yet but I think we're producing what are called TDRs, Technical Data Reports, on all of these things and I think they are in the public domain.

(Question) - As your charter is right now, are you only concerned with the waste that's in the containment now or are you concerned also with what will have to be taken care of when you get around to cleanup of the reactor primary system?

(Discussion Leader) - We're concerned with that too. However, the fuel is a separate problem, in terms of how it gets processed. There's going to be a lot of

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concern about moving it, containing it, and ultimately disposing of it which will be separate from the decon radwaste management function.

(Question) - But say that there's uranium oxide in the reactor that's going to come out somehow. Is it the responsibility of this waste program to handle such material?

(Discussion Leader) - That's a good question. You're talking about the fact that there may be particulates in the water itself. . . .

(Comment) - We're going to be awfully lucky if there's not loose uranium in that core. . . .

(Comment) - Very definitely there will be things like uranium and plutonium. They've already been seen in trace quantities, in the parts per billion range. However, the pH of this water is 8.1 which is just not the kind of water that plutonium and uranium like to go into. You don't see the spectrum of radioisotopes in that water that you would expect if much fuel were being dissolved. On the other hand, what's been said about particulates is correct. There may be traps--knock-out drums and that sort of thing--like the tank into which the pressurizer relief valve vented. It may be a strong source of particulate contamination towards the bottom of the containment.

(Question) - In the sump itself (interrupted)

(Comment) - Where these samples have been taken is pretty far from the sump itself.

(Comment) - There's a tank at West Valley that has 40 kg of plutonium in it. If I analyze the supernate, however, I find only 100 parts per billion of Pu. But I know those 40 kg are there because they were inventoried going in. I can't account for it in the supernate so I know it's down at the bottom with the precipitates. This may be what you'll see here--you may have uranium at the bottom of the sump. Eventually, to get the containment cleaned up the way you're talking about, it's going

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to have to be moved out. When it's moved out, you're going to have to decide how you're going to trap it and what you're going to do with it.

(Discussion Leader) - I guess I misled you when I answered your earlier question. In terms of getting the bulk fuel out, that's one set of problems, but the particles of fuel that have migrated out of the core and are or may be spread around the containment, that will be part of the radwaste problem. We recognize that it may throw us a curve in terms of the regulations that will apply--such as the 10 nCi/gm.

(Comment) - We talked this morning about RC system decontamination. For every flush of the RC system you're talking about up to half a million gallons of some type of contaminated solution which you're going to have to treat and then you're going to have to solidify and dispose of the contaminants you've removed. Their nature hopefully will be such that you won't have to have a separate treatment and disposal system to take care of them.

(Discussion Leader) - Once we start in on the RC system, we'll have to be prepared to find some uranium fines around the low points and collection points. We'll just have to be ready to deal with them when the time comes.

(Question) - Is there going to be significant amounts of plutonium and americium?

(Response) - Not a whole lot, based on the relatively low exposure of the fuel, but there is likely to be enough of these and other alpha emitters distributed throughout the RCS that wastes from its cleanup will be categorized as TRU wastes.

(Comment) - If you felt sure that was going to be the condition, I'd think it would sway your thinking towards the glass technique for waste solidification but if you were fairly sure this was not going to happen, you would have the possibility of solidification in concrete. It depends on how much or how little uranium you think there's going to be to clean out of the system. There is the possibility that you could segregate the wastes and have two different solidification systems.

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(Discussion Leader) - Let me ask a couple of questions about handling strippable coatings. Ray King of BNWL indicated that they stripped the coating off the floor of their contaminated building at Hanford and compacted the pieces just as they were but I'm not real sure about that. Has anybody else had any experience with strippable coatings? Would we be just compacting it in the form it's in or are we going to have to do something else to the strippable coating, if we use it, in the way of a process to solidify it?

(Response) - At the earlier session on exotic decon methods, Mr. Testa of Commonwealth Edison mentioned that they had used compaction in handling large pieces of strippable coating like you would have to deal with here. They used large wooden crates and through a compaction system out of these into 55 gallon drums. They had good results with just compacting for low-level waste disposal.

(Comment) - Where you don't have a lot of transuranics, I think you could treat it like low level waste but Ray King had a special problem there at Battelle.

(Question) - Did you say you had an incinerator on the site?

(Discussion Leader) - We're looking at volume reduction by incineration but I don't know whether you could take strippable coating in its normal form and incinerate it.

(Comment) - Most of the strippable coatings are water-based solutions which form a relatively thin tough rubbery film as they cure. They all contain chelating agents but their detailed formulations vary for different applications and generally are considered proprietary. They also vary in fire resistance from types which are useful only where fire properties are not a consideration to other types which meet present ASTM flame spread criteria for coatings.

(Question) - They are water-based but wouldn't exposure to heat or fire conditions drive off the water? Shouldn't they burn then?

(Response) - Of course.

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(Comment) - But some of the products are made so they will not burn.

(Comment) - To get approval of the NRC to use it in the auxiliary building, we had to show compliance with ASTM-E-84 criteria for flame spread, fuel contribution and smoke inhalation. In addition, we had to prove it was compatible with charcoal filter systems. But we do need some additional data on the leach properties so that we can prove that when it comes to the supreme test, disposal, it is comparable to the Dow media in terms of its leach properties.

(Discussion Leader) - You mean in terms of the stuff migrating off the strip-pable coating and just meandering around.

(Comment) - Exactly right. Once we can prove the characteristics of this material as a solidified waste, it would take care of that part of the program. We do need the data. As a matter of fact, the Battelle people have a project going on now for conventional solidification and we are exploring the possibility of them tackling on this material too, if you people tell us it makes sense.

(Comment) - Just because it won't propagate a flame doesn't mean it won't burn. You really have to look at the chemical composition to find out whether it really will burn and you can incinerate it because those tests are funny tests.

(Comment) - That's exactly why we raised this point. Having flame spread properties within specs doesn't mean it won't burn.

(Comment) - I would guess there are halogens in there.

(Comment) - I understand it starts giving you some fits if you put it in an incinerator because of the stuff that comes off in the gases. Your scrub system starts to give you trouble--when that starts to happen.

(Discussion Leader) - Let me ask another question. We seem to be addressing the health physics type of problems. Do these decontamination methods we've been talking about pose any other occupational type hazards? I remember Parrish of VEPCO

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talking about the fact that they had some fumes and people wound up in the hospital with some sort of gas inhalation problem. Are we forgetting other types of nonradio-logical hazards?

(Response) - There is one I can think of. Some of the gas canisters, on various fumes, do have a limited lifetime or volume that can go through so the monitoring people have to be very careful that they don't have them on the face masks longer than specified. It is very easy to forget and to have them on too long or at a fume concentration that is too high. With some of the solvents, TURCO for example, you have to be careful that you have the right canister and even then you can keep that canister on for only a certain length of time at a given fume concentration before it goes straight through the canister. So you do have to take a good hard look at what canisters are being used and what solvents are being used for decontamination. The normal health physics type canister probably won't be suitable for some of the decontamination solutions. You'll have to look at the industrial type for those situations and you will have to have a method of checking to be sure that the right canisters are used.

(Comment) - I think your decontamination solutions will have to be reviewed critically. You should have an approved list of those you can use routinely and nobody should be allowed to use anything else. We have a system at our plant in West Valley where certain chemicals are approved to go into that plant and if someone orders something that isn't on the list, he doesn't get it at the plant until it is approved. You're going to have to do something like that here.

(Discussion Leader) - Do we face any situations like were referred to where a combination of solvents and other materials poses a problem that might not normally be faced in an operating facility?

(Response) - There are those possibilities with some of the cleaning solutions which generate certain gases that you have to be very careful about.

(Discussion Leader) - I'm not into this kind of stuff . . . aren't these things well documented?

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(Response) - They are, but you have to go through and take each one specifically before you really have a handle on it.

(Comment) - I think what we're saying is that your procedures have to be reviewed very critically like by an industrial hygienist and like the respiratory protection factors being reviewed from the industrial hygiene standpoint. Each one has to be considered on a case by case basis. Otherwise you won't know what it's going to do in combination with other chemicals that are present. I think a lot of the hazards can be recognized in advance if this kind of systematic review is made.

(Comment) - You also need to give the waste management people a crack at what chemicals are to be used. That came to my attention several times this morning. Those people should be in on it early because they have to do the treatment that ends up as a polished liquid and some sort of small-volume solid. They ought to have a crack at planning what's going to be used, early on.

(Comment) - Another one is that some of the companies put out what they call proprietary compounds. You have to find out what those chemical compounds are before you use them. You have to insist upon it. . . .

(Comment) - OK, but how are you going to protect the companies when you're disclosing the whole thing?

(Comment) - Right now we are really interested in protecting the individual who is going to breathe in the area. The proprietary aspect has to be handled--I'm not saying it doesn't--but you just have to be sure that somebody doesn't get a good snootful of chlorine or something like that because of a proprietary compound that we didn't know has the bad actor in it. It can be handled. It's not an easy job but if you're going to provide health protection, you have to make the effort because you can't afford that kind of surprise. The trade names stay the same while the compositions change from year to year. That has happened. We knocked out two people but fortunately there was a third one there to get help in pulling them out of an area where the canisters were not the right ones for the particular formulation being

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used, we found out later. I understand the companies want to protect their products but we also have to protect the people.

(Discussion Leader) - I don't want to wander too far off the waste management aspects of plant cleanup so let's shift gears for a second and talk about local decon waste management along the lines described yesterday by Parrish of VEPCO. What have we got here in terms of experience in decontaminating a localized area and not letting the resulting wastes migrate?

(Response) - I was quite surprised by the reported experience in the Aux Building where you seemed to go from cubicle to cubicle in your cleanup and not have to take any measures to insure that you weren't recontaminating that area. You seemed to have no problem in doing that. That's not our experience at Battelle-Columbus. We have to make sure that air flows are going in the right direction and put up plastic barriers because we seem to encounter recontamination and resuspension all the time and you didn't seem to have those problems or at least it wasn't stated.

(Discussion Leader) - Well, there were problems like that. They weren't generated, as far as I know, by air flows being wrong or people going back into a clean area and dirtying it. Recontamination there resulted more from the fact that even though they did a good job of cleaning an area, the source of the contamination had not been isolated and eliminated. There were valve leaks and whatnot in the building from which the stuff would just continue to come so when you went back in you'd find the same level that you knew they had before they went in and cleaned up but it wasn't because of any improper health physics type of recontamination problem. It's just that the source had not been isolated or secured.

(Comment) - You have to go back and see what the circumstances were that would affect movement around. I have the strong suspicion that it was kept wet. Based on experience at ANL and at Idaho, it's when it gets dry that you start having the resuspension and contamination spread. If you keep it wet and are very careful about it, the resuspension may not become that much of a problem.

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(Discussion Leader) - Are you saying we should use this as a method of decontamination control? To keep the cement walls and floor wet?

(Response) - Yes, it is one technique. Keep it misted; keep it watered down; we used foggers for this; and it will save you quite a bit.

(Comment) - In the Aux Building, with their cleaning process, they gradually got everything down to safe limits and they did monitor air samples daily--it was constant. In their cleanup effort, the areas that had the major portion of the traffic, they were the ones they concentrated on first. By removing all the debris out of there, that also took away the possibility of anything new being released. They had some problems with the new air systems being installed there but, overall, things were monitored all the time and the contamination went down to nothing.

(Comment) - There is one thing that you have to remember. They haven't gotten to some of the more contaminated areas yet. For example, there are the cubicles where you have the tanks full of liquid waiting to be processed through Epicore 2. What I'm saying is that maybe the experience base from cubicle cleanup to this point is not all that strong.

(Comment) - A lot of those cubicles that they were talking about just house motor control centers and some other items that could contain the contamination. The areas that they can't get into do have a high level of contamination.

(Comment) - They won't be able to get into those cubicles without using remote decon procedures so they may turn out to be pretty tough.

(Comment) - I think what he's saying is, don't be lulled into a false sense of security by this relatively favorable experience to date.

(Comment) - On Dresden Unit 1, we had to take some metal samples off of our reactor head and the general contamination was between 200,000 and 500,000 counts per minute. I told the people who were going to work on it that it was an absolute

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necessity for them to have a tent built that they could grind inside of which had a pump which pulled ventilation air from the enclosure. The exhaust air then went through two HEPA filters and we pulled air samples while they were grinding and, because of this setup, we didn't go airborne at all. If we hadn't had the tent, it would have been an impossible situation and we probably would have lost most of the building.

(Comment) - We suspect a lot depends on the particle size. I'd have to say that in the West Valley cells where we sheared the fuel, we estimate 3500 Ci is contained in there as uranium oxide fines from the shearing operation. We pull air samples from those cells routinely. I looked at a set of those samples just before I came to the meeting and the air inside the cells is almost MPC. I'm sure if I would get in there and blow some air around pieces of equipment, I'd resuspend it, but just sitting there with normal ventilation on it, the particle size is such that it stays settled rather than becoming airborne and moving around. Even where contaminated surfaces have dried and nearby activities keep you from maintaining low ventilation air flows, how much is resuspended depends on the particle size you're looking at.

(Comment) - I've also worked in radwaste basements after we lost tremendous amounts of water from leakage and the smearable contamination has been greater than a million counts per minute and the air sampling results were just above half mask. So, even though you can have a disastrous situation contamination-wise, your airborne situation might not be bad at all.

(Comment) - It gets back to the fact that, as Wes said, it really depends on your particle size. Depending on the type of accident you had, the amount of vaporization of fuel if you have that, will drastically affect the particle size. If it is simply a physical disruption and breaking of fuel, then you're not going to have high aerosol concentrations. If there was any sort of vaporization of fuel, you're going to have a tremendous amount of submicron fines and your aerosol is going to be very high and that's what you're going to find out once you get in there. I don't think there's any way of predicting what the temperature of the fuel was. There are lots of estimates ranging from vaporization on down. . . .

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(Comment) - I think the way to approach it is to expect the worst and hope for the best.

(Discussion Leader) - I think that's the way we are going. Well, I can't believe we don't have more things to talk about in terms of waste management.

(Question) - In the first morning's presentation, about the overall recovery plans, we talked about the Epicore 2 and the SDS systems. The plan was--they mentioned solidification but there was a possibility of an evaporator being installed for decontamination, but that was sort of left dangling, I guess. What is the current plan? Is that still a real option? When will the final decision be made?

(Discussion Leader) - There is a radwaste evaporator currently being purchased and there is a radwaste evaporator building that's going to go next to the Auxiliary Fuel Building. The unit will have 15 gallons per minute capacity. As far as I know, that is the current plan.

(Question) - Is that a remote facility? Is the evaporator remotely operated?

(Discussion Leader) - I don't know . . . I suspect it is. You know, a lot of our decisions right now are being influenced by the cramped nature of the facility. There are an awful lot of things we would like to do differently if we had the room. Arrow-smith showed the Containment Service Building that we're putting outside to facilitate the recovery effort. That is the intermediate staging area for the decon waste as we proceed with recovery. To give you some idea of what we're doing, the equipment hatch is on the southwest corner of the containment building. The Radwaste Evaporator Building is being put near this area. The Containment Service Building which is being put in will wrap around the equipment hatch. We are not exactly sure where the DOE decon facility will go but currently we show it off in a corner. There is a horrendous structure right outside of the equipment hatch which has a two- or three-foot thick aircraft crash shield that fits across the equipment hatch when they're in operation. There are some stanchions and so forth which permit this thing to slide back and out of the way. Currently the way the layout is, and this is a moving target by

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the way, as of my last look at it the area behind the shield and toward the containment building will be an intermediate radwaste station facility. An "air envelope" is going to be put around the equipment hatch which right now is a big metal dish something like 22 or 23 feet in diameter. We're going to take that thing off and put on another metal dish with doors so that we can have better access. There will be double doors with electrical interlocks so that, once we get the head off the reactor vessel, containment integrity can be maintained while they are moving the fuel. There has to be an air envelope maintained so what we will do is to have the two doors interlocked so that one can't be opened unless the other one is shut and we will have the ability to bring material, equipment, people, etc. in and out.

(Question) - Will all transfers in and out of the containment be made through there? Fuel, for example?

(Discussion Leader) - The separate personnel lock will be used for its intended purpose. Sizewise, we think the equipment hatch opening would accommodate a large shielded cask but current thinking is that fuel will be removed by way of the normal transfer route. We are flexible though. Anyway, there will be this staging area outside of the containment and, in terms of the health physics type of thing, we're hoping that we can maintain the reactor building as the so-called hot spot and anything that goes across the staging area barrier is clean from a surface contamination point of view or is bagged, double bagged or whatever is called for, so that we don't have contamination problems outside. Items can be brought into our conventional decon facility where there will be tanks, steam baths, hydrolasers, chemical cleaning provisions and so forth. What will happen to a particular item when it comes out depends on what we're going to do with it. This will be a difficult traffic control problem because there is going to be trash coming out that is just that: we won't have to stage it, we'll just get rid of it--there is a truck bay located somewhere nearby to facilitate this--we will have trash and low level waste compacted in boxes as it comes from the containment but we also will have components coming out that we're going to want to decon first and then dispose of as low level waste and then there's going to be stuff that we will take out that we'll want to clean up and then put back in again. We don't know whether they'll be cleaned in the DOE facility or in the conventional setup but all this stuff will have to be staged in this one area so what is

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waiting to be worked on and what is waiting to go back in will have to be carefully segregated. I don't believe any of the facilities to date in their experiences have looked at the volumes of stuff that we're going to be moving in the time period that we're going to try to move in. Another consideration is that the personnel access control facility is being put in here to handle 200 people per shift; 150 scrubbers and workers and 50 health physics types that are going to "baby sit" the people inside the containment. Whether or not we can handle that I'm not really sure.

(Question) - You've put quite a bit of emphasis on things that you're going to be taking out of the containment and there is quite a bit in there but isn't your main concern your pressure vessel and your primary loop?

(Discussion Leader) - But I can't get to it yet. . . .

(Question) - This is just the beginning of it then? You're cleaning everything else out before you go into the primary loop? Is that the philosophy?

(Discussion Leader) - That is the problem there. We've got to clean it up enough so that they can get in there and do it in a low radiation level environment. We're going to have to do as much cleanup as possible before we open up the reactor cooling system.

(Question) - This is all before you break containment?

(Discussion Leader) - Well, before we take the reactor head off, there are three phases to this recovery. The first phase is what I just described--building all these facilities, the radwaste staging area--getting in there and cleaning the place up. Phase 2 is opening up the reactor pressure boundary and getting the fuel out and cleaning up the reactor cooling system. The third phase is to requalify and reconstruct and go back into operation.

(Comment) - The way it's been stated it sounds like just about everything removable, electrical equipment and even the larger components, are all going to be brought out. Your staging facility is not going to be able to house all that.

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(Discussion Leader) - Wait a second. There are a lot of factors that influence the size of this facility. We would like to make it a very large building, but let me state some other criteria before I say more about the size. The staging area enclosure is not any kind of environmental, radiological barrier. We don't intend it to be that. Everything that's going to be put in there has to be bagged. It's not a hot area. We intend this to be clean. For general access, people won't have to wear anti-C's to walk around there. They are going to have to when they get into specific areas but for general areas. . . .

(Comment) - You have to assume that you've got an emergency and that the areas get contaminated.

(Discussion Leader) - Wait a second now. This building is going to have two-foot thick concrete walls, coated and decontaminable. All the conduits and pipes are going to be ten feet off the ground. You know we're designing it so that it can be cleaned up

(Comment) - What you're saying is that it's not going to be normally contaminated but that it's designed as though it will be.

(Discussion Leader) - We don't intend for it to get contaminated but we're assuming that it will be. There are other things that influence the size of this building, as I understand it. First of all, there is going to be no sharing of facilities with Unit 1. There is a fence that is being built right down between the two units. There is going to be no cross-talk with personnel--no access from one side to the other--this is a security fence for the protected area. You have to understand that there are other criteria we have to live with right now. One of them is the safeguards regime, so we have this fence for the protected area. One of the criteria for this fence is that there has to be 15 feet clear on each side, and there just isn't any way you can keep moving this fence out so that you can have better access to this proposed work area. We also have to have road access in there to get some of the larger components out. So, the staging facility building is limited in size going one way because of fence clearance and access requirements and is limited in size going the other way because the Turbine Building is right there and there's access to it that has to

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be maintained--railroad tracks go right in through there--so it's as large as it can get. Now the building is 40 feet tall and there's nothing to say we can't stack this stuff but it's going to be one tremendous problem actually knowing where things are in this big area that we're using for a staging facility. It might be that our decon or recovery is limited by space. It might be limited by a bunch of other things too but it might end up that what we can do in the containment is limited by our ability to bring the stuff out.

(Comment) - Security is one of your major influences, obviously. Here you're talking about all your security trenches and protecting the cable runs around the perimeter. You don't need all those things for a shutdown plant--they should allow some concessions in view of the conditions--where you want to work is directly in the path of all the electrical security and communications interties that operating plants have to maintain. . . .

(Discussion Leader) - We will be building our facilities and supports so that they don't impact those systems. There are a lot of things they should give us concessions on, especially in terms of safeguards--I don't know what anybody could do in terms of terrorism that hasn't already been done, but we still have to recognize the rules and regulations.

(Question) - What really is the problem? Why can't you move it out of the staging area if you have it cleaned up or bagged or whatever. . . ?

(Discussion Leader) -- But there's a limit to the traffic we can handle. I can't get it off the site. . . . I'm going to have to truck it over to the radwaste acreage, or someplace. There's nothing to say I might not end up taking some of this stuff out and then bringing it back later and deconning it, or whatever.

There were some questions asked during our break just now. One was how we thought we could keep all the concrete surfaces wet after they're deconned--I don't think we intend it. One of the options we have is the use of a strippable coating. You go through the decon, or you don't even have to decon if it's a low radiation level

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area. All I have to do is apply this stuff everywhere so that it fixes any contamination in that area and I can proceed with decon of other areas of the containment and come back later, at my leisure if I can call it that, to complete the cleanup as needed. Also, I can put the strippable coating on a cleaned area and I won't recontaminate the surface from any redistribution of stuff within the containment. That's not to say that contamination leaching back out in some way won't pose a problem, but the strippable coating should help in that context. There are other "tricks of the trade" which I'm not up to speed on that we'll try to help the radwaste management effort with. Another question is in regard to airflows. We're designing things so that, during the entire recovery operation, flow will go through the airlock and through the installed HEPA filters before being exhausted out. The flow will always be into the containment and will maintain the Containment Service Building at a slightly negative pressure the whole time. This building will be designed for a slightly negative pressure, an eighth of an inch water gauge or so, and it definitely will be maintained slightly negative during recovery operations. Some of the other things that are going on in radwaste management are that GPU is looking into a computerized inventory system so that we can keep track of the radioactivity as it moves through the plant. I'm not sure there's a specific requirement that we do this, but everybody would be a lot more comfortable if we have a way of knowing where everything is so when somebody says, "You said you took 750,000 curies out of the containment but show only 600,000 curies in solidified waste, so where's the rest of it?" we'll have the basis for giving a firm answer. We're looking to have a fairly integrated computer system to keep track of the radioactive materials. It will require manual entry of conversion factors from instrument readings to curies of contamination but if it's on a system, we should be able to do a better job. That's some of the things we're looking at.

We mentioned briefly, and I'd like to bring it up again, the volumes of water we have to take care of. There are 530,000 gallons in the containment sump, another 300,000 gallons in the Auxiliary Building and 90,000 gallons in the reactor cooling system. All of this water is tritiated to some degree. One of our radwaste processing problems is that none of the processes we've envisioned does anything to tritium, so we're going to end up with about a million gallons of treated water at somewhere around 1/2 microcurie per liter tritium concentration. One of the things some people would like to have done with that water after it's processed is to spray down the

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containment with it and then clean it up again. We're not really sure whether that's a good thing to do. It doesn't pose any problems in the context of its tritium activity, but it is also borated. If we use it to spray down we're going to have to deborate it so that's another process we're going to have to consider. One of the things we would like to do is to pump it out to that pond I mentioned and let it sit there until we're ready to use it again. We're not going to be releasing that water. Right now there is a court injunction against discharging anything off the island, especially tritium. In fact, a week ago, some people from Baltimore were demonstrating because there was talk about the Three Mile Island discharging tritiated water into the river. If they were to do it, there's nothing to prevent them from diluting it to well below any regulatory requirement for release of tritiated water, so it will continue to be considered but it won't be readily accepted even if it would be completely safe. If we did deborate the water and wanted to use it for localized decon efforts, it would pose a problem, I believe, because one of the things that we would like to do is to make these nonrespirator areas somewhere along the line, but I don't think we can do that if we're using tritiated water without having a very tight health physics program and analyzing potential effects every instant. It would be a lot cleaner administratively to put this water in a storage pond for later operational use than to try to use it for decontamination or to discharge it off the site. I would appreciate it if anyone has anything to say on any of these things we've been talking about.

(Question) - Do you have any information on the effect of the difference in boiling point between water and tritium oxide? Because you may end up concentrating it by evaporation to higher specific tritium activity levels, your utilization or release problems would be worse.

(Discussion Leader) - No, it's just the opposite. Tritiated water preferentially evaporates, as opposed to regular water. Therefore, it is a release mechanism that will end up with more clean water than you start with.

(Response) - So you have inequivalency. . . .

(Discussion Leader) - Yes. Tritiated water evaporates preferentially--it's not that big a thing, but it does. . . .

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(Question) - Would this be a covered pond so you won't get rainfall equivalent to evaporation, in volume?

(Discussion Leader) - No. . . . I don't really care how it's evaporating, I don't think it will pose any kind of an offsite dose problem.

(Comment) - No, but over the years you may slowly build up as rainfall exceeds evaporation.

(Discussion Leader) - That's true, but I'm sure that there's going to be plenty of freeboard in the pond itself to take it into consideration.

(Comment) - I think you'd better do a fairly quick inhalation calculation just on the outside of the fence right there because it's at the end of the island. . . .

(Discussion Leader) - We are. Where we locate this pond is going to be predicated on an analysis we are doing right now—to say whether this is in fact feasible, in that aspect.

(Question) - What's the volume of the spent fuel storage pools that are not filled at the present time?

(Discussion Leader) - I think the pools hold somewhere around a quarter of a million to 300,000 gallons. . . .

(Comment) - You have a once-through system for treating water and you've probably got a million gallons you have to treat initially, based on the inventories you quoted. That material could be held, but when you start deconning using larger volumes of water, this is not tritiated, so you no longer have the problem.

(Discussion Leader) - That's right. There would be an end to it. Once we process all this "accident" water, we would keep it segregated from everything else, and there's a lot of things that make us believe that we're going to have to

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(Comment) - One use would be to use it in your canal, I believe, if you don't have an inhalation problem with the 1 Ci/cc of tritium in the containment sump water. I don't know whether you'd have a problem with it on inhalation but you certainly could demineralize that water and use it in the canal.

(Discussion Leader) - That is one of the options--I don't know if I mentioned it here--that is an option to take this water and store it in a pond for 3 or 4 years and, when I'm ready to defuel or use the spent fuel pool . . . I don't even have to deborate it. I can leave it out there borated, then bring it back and run it through the demineralizer and put it in the pool. I've got some boron in it, I don't know how much it would be. . . .

(Comment) - Right now if you use Epicore 2 as a polishing system, you're deborating--below drinking water concentration, and you have an EPA standard for release to the environment--it's below that.

(Discussion Leader) - Would SDS do that?

(Response) - As SDS is now conceived, there is a "black box" shown in the line which would deborate--it's absolutely essential.

(Comment) - You could handle it--by proper selection of resins. . . .

(Discussion Leader) - We're going through this selection process and are trying to optimize among all the various options that are available to GPU to do something. It would be preferred if we could just dilute the accident water with service water discharge and then let it go in the river--it would be well below any of the regulatory limits--except there's an injunction that says we can't do that.

(Question) - Let me ask you, do you have a lot of bare concrete in the containment building?

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(Discussion Leader) - The only bare concrete place, I think, is--there is an elevator shaft that has cinder block walls, uncoated. Everything else is coated. By the way, there is one other problem with all this stuff. If you saw the pictures Tuesday, the reactor core drain tank and the release point for the accident is right at the door--to the stairwell and elevator shaft.

(Question) - What do you plan to do? Do you have anything in mind for cleaning up the elevator shaft? Is it possible?

(Discussion Leader) - It might be, but I'd just as soon disintegrate it--just take this stuff out and build another one.

(Question) - Is getting the elevator to work going to have to be a high priority item?

(Discussion Leader) - We are going to have to get the elevator to work, but I think that the main thing will be to get the polar crane to work because the polar crane allows us to do a lot of things we couldn't do any other way. That will probably be the first order of business once we get into the containment with any kind of magnitude of people.

(Comment) - So you actually need the elevator.

(Discussion Leader) - No, this is just an elevator that allows us to go from the basement to the 347-foot level, whereas the polar crane sits up in the top. That elevator is going to come into play--they would like to use it too for an awful lot of things--but we won't need it right away like we'll need the polar crane.

(Question) - How do you get to the polar crane?

(Discussion Leader) - The elevator doesn't go all the way up there. It stops at the 347-foot operating level. The polar crane is way above there. We'll have a problem getting people up there to decon and repair--it's going to take them a while.

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Do we have anything else? It looks like we are winding down. I would appreciate it if at any later date you think of something that should be part of this that you'll forward it to GPU or to me so that we can factor it into the studies. We're studying the living daylights out of everything, not just once, but two or three times and not always by the same organization and things are bound to change some each time we study. So--I would hate to think we went through this entire evolution and forgot some pretty obvious things just because somebody went over the topic earlier but neglected to ask the right questions.

Well, I certainly appreciate the time you've spent and I would like to thank you for your attention and your contributions to the discussions. Thank you very much.

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ATTENDANCE LIST FOR DISCUSSION SESSION ON DECONTAMINATION WASTE MANAGEMENT

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Decontamination Waste Management Techniques Workshop

ATTENDANCE LIST FOR DISCUSSION SESSION ON DECONTAMINATION WASTE MANAGEMENT

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HANDS ON DECONTAMINATION WORKSHOP

DISCUSSION LEADER - TOM BLOCK (GPU)

Hands on Decontamination Workshop

Discussion Leader - Tom Block (GPU)

We will first have an update on decontamination at Three Mile Island by Bruce Irving (VIKEM).

(Irving) - We were brought to Three Mile Island after the first week, to assist Westinghouse in access to the decay heat removal system to insure its reliability should that system be needed. You're all aware that to take that high activity to the auxiliary building through the decay heat system would be an undesirable move. Due to high radiation levels, it was elected to insure full remote system operability, should the need arise. Most of the radioactive coolant overflow was centered on 281 around the aux sump. The general area, about one week after the accident, was 1R/hr. There were many localized spots up to 10R/hr at waist level from the contamination on the floor. Our initial effort was to knock down those doses to allow Westinghouse technicians to get in to stabilize the decay heat system. The lower level of the diesel generator building was up over a million dpm smearable. The upper level of the diesel generator building, just from tracking, was in the several hundred thousand dpm range. The auxiliary building itself was generally 1R/hr general area. Three to five R/hr hot spots were frequent at the lowest point on the 281 level. At the 305 level the contribution was due to tracking, and general background was 700,000 to a million dpm. The highest smearable area was up to 2 million dpms. The 328 level was slightly lower than that.

The initial thrust was to clean up the diesel generator building for access, and use it as a staging area. We tented at the door between the diesel generator building and the auxiliary building. That took us to sometime around May 5, and the decontamination effort stopped because there was a need for construction activities to move into the building. At that point there were large volumes of pipe, staging, tools, etc. brought in and the decontamination effort was "on hold" while important maintenance was taking place.

About the first week in June, much of the emergency construction work was complete and we then went into a full decontamination effort. It took about two months to get the building under control in a sense that we didn't have a problem trying to get out the tent. Originally, just getting out of the tent, it was all we could do to keep it down to a million dpm.

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By mid-July, contamination was pretty much under control. We were still dealing with localized hot spots of 100,000-200,000 dpm, but generally it was under control.

Right now, the open areas are in pretty good shape. Generally less than 1,000 dpm up on 305 and 328 levels, and less than 5,000 dpm down on 281 and that's due to miscellaneous equipment installation. There's a lot of construction going on at 281 levels right now. Cubicle-wise, we've got about 50% of them under complete control. The only areas we have not attacked are centered around the makeup system and waste tankage; the beta problem that occurred in August produced a beta field in the makeup valve room due to a valve packing failure was 5,000 to 6,000 R/hr. That room also had contact dose rates up to 50 R/hr on piping systems. That area hasn't been touched. Another valve room at the 305 level associated with the makeup system hasn't been touched. The auxiliary building sump and sump tank room and miscellaneous waste holdup tank area have not been touched. The three bleed tanks which contain RCS water have not been touched, again due to dose. Makeup pump system cubicles and access ways are about 50% complete.

The tankage situation is such that to desludge the tanks we're waiting on Epicore. As fast as they move the water, we'll be in there to desludge. The intent being to utilize clean, Epicore process water for hydroblasting, underwater spargers or whatever we need to take the mud out of the tanks. As far as the building itself, at present we're doing a lot of contamination control as opposed to decontamination. We've had a full survey of all overheads done the first of November, the respiratory masks came off. The comprehensive survey of the building showed the maximum we were looking at was about 30,000 dpm any place in the building in accessible areas other than those areas I mentioned earlier.

We're running contamination control programs for activities that go on in the building. Access is fairly free if you're going in on a general inspection (only a single set of pc's), a couple pair of booties, cotton gloves and boot liners.

With regard to methods; we've tried manual scrubbing with long-handled scrub-brushes, power buffers and a variety of solutions. When we first started we contacted the Radiac wash people for a recommended dilution. They had no recommendation for the dilution. The floor on the 281 level was stained quite heavily and a 4:1 dilution

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provided a good sudsing action which was vacuumed up. On second passes, we tried 8:1 and the combination of these two have proved successful so far.

We proved we could solidify the Radiac wash with various reagents such as Dow and cement. No other chemicals seemed to work any better than the Radiac wash although no real comparison tests were made.

We had several different vendors recommend a pulling agent for leaching processes that were going on. We'd go through tests on some heavily contaminated areas using their specifications, but we haven't found anything that will pull contamination from the concrete. These things were tried on painted and unpainted surfaces. The contamination has been found mainly in the paint surface.

We had Battelle Northwest run a study for us with core boring samples at the 280 level in the auxiliary building. They did audioradiography on it and penetration was shown to be slightly into the sealer, but not into the raw concrete. Two core bore samples from the elevator shaft, which is a sump that flooded on the 280 level and had no drains installed. They're being shipped out for analysis.

In this facility, this elevator shaft had unsealed surfaces, no cement finish, the initial rates were 3-7R general area after pumping. This was totally unacceptable. Because of the loss of the elevator pit, everything had to be carried upstairs, the bubble suits, etc. The construction personnel were really working hard. If it had just been sealed with silicone, etc. our problem wouldn't have been so bad. The lesson there is to look at those areas that are hidden, the ones you don't even think about. About 1800 gallons of 60-80 microcuries/ml. of water sat in that hole for two weeks. No matter what we did to that wall, we were still running 100 mr. in the elevator cab. We finally brought in lead plate, which was attached to the wall.

We cleaned some of the floors and then used a strippable paint which proved satisfactory. One problem with strippable paint is that metal tools, etc. tend to rip it up. In general, we have had good success with it although if some over-spray occurs when it is applied then it is very difficult to remove. If it is applied properly, in a heavy layer, it's easy to remove by rolling it up. In the Epicore building, we came up about 3 feet on the walls, but we haven't done any higher areas with it. When applied on higher vertical surfaces, it had a tendency to thin out and

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it must be reapplied to get a thicker coating on it. Being a water base, with high humidity, it takes a long time to dry. In an area which is well ventilated, it'll be set up in 4 hours. It was used in the elevator shaft to seal against airborne and it took about 3 1/2-4 days to set.

(Question) - When you put it on in layers, does it work as well?

(Answer) - We found that it can be applied in layers. When it is stripped, then, it comes off in layers, too.

Strippable paint was used at the 281 level annulus, which is a rough concrete surface. The survey after painting showed that the beta dose rate had decreased up to 80% in some places. It definitely did keep the beta levels down.

(Question) - How did you decide how you were going to do things? For example, it seems that the methods seemed to be ones that would minimize water.

(Answer) - We had surveys to tell us where the hot spots were. Initially it was all wet vacuumed. No hydrolasing was used. Use of Radiac wash is pretty standard in the industry.

Early in the game, all three bleed tanks were full; there was approximately forty thousand gallons left in one tank and the tanks held 83,000 gallons apiece. The neutralization tanks were full, and the auxiliary sump was full. There was just no place to put any water. In some places we went with straight Radiac wash, no dilution, for a good month until all open area gross were knocked down--this was to minimize water use. The crew supervisor was the only one permitted to dispense the Radiac wash to eliminate indiscriminate use of it. It was reused in some areas as we weren't concerned with cross-contamination because the level was so high anyway. Radiac wash is a trade product made by Atomic Products near Philadelphia. It's basically EDTA. It's 100% proprietary and the chemical composition is not accessible to us. The Radiac wash was used because it took less of it to do the same job as twice as much water.

Back about July, we were somewhat concerned about leaching and wondered whether dropping atmospheric pressure was pulling out activity from the pores. We

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had several rather severe storms back then, and we thought we were getting significant pull as the weather front would go through. In the end, though, we convinced ourselves that that was not occurring. The leaching was just a natural function and slight scuffing and abrasions were bringing it out. This was confirmed when we found the paint chips contained essentially all the activity. Chips were taken for beta analysis back in early June, and the bulk of activity was found to be trapped in the chip. The paint was chiseled off for samples to be run.

(Question) - How do you monitor man rems?

(Answer) - Penetrating, whole body. We also monitor beta. The beta recorded to date, to personnel, has been essentially negligible. Early on in the work, we had our people use the beta rings.

The way we kept the beta dose to such a low level was when we did the annulus job, we wore fireman's boots which went up to the knees. Under those we wore the regular booties. We had TLDs inside and outside the leg, which proved that all the beta could be stopped. Very thick, insulated pants (what the firemen call "night hitches") were used. There was very high beta in the annulus and the boots did the job.

We scrubbed the surfaces hard. We used coarse grade buffers and it opened up the surface and allowed us, on subsequent passes, to remove considerable activity. We tried to protect the paint surface in heavy traffic areas by using less abrasive pads.

We definitely still have migration due to the ventilation system in the fuel handling building. There are two corridors, on 305 and 328 levels, where, prior to doing containment annulus, we could get down to 5,000 to 10,000 dpm with a regular cleaning. Surveys the next morning from just natural convection currents taking up out of the annulus through the gradings of the annulus on the 305 and 328 levels would result in 200-500,000 dpms smearable. That was early in June.

When we first went into the annulus, we used Scott Airpacks and the air was around 10^{-9} Ci/ml and whenever they'd go in for air samples the dust was stirred to about 10^{-7} Ci/ml. So, before going in for the samples, we'd spray a fine garden

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hose from the next floor up and misted the whole area to keep the dust down. That's what we continue to do--mist down a room before we enter it.

The annulus was critical because the two floor drains were the lowest in the building and when the water came up topside on the overflow, that's what got it first. When the flood occurred, the annulus got it first. There is a door to the annulus right next to the room Westinghouse had to get into and from the iodine on the floor the door was something like 20R/hr. Once we got it roughed out and got it sealed off with strippable coating, the migration up into the fuel handling building was gone. We do have trace migration going on now which I attribute to the makeup valve room which is inaccessible.

(Question) - Would it be possible to seal some of these electrical cable penetrations off with some "polycel foam spray" temporarily?

(Answer) - We did a number of areas that way. This particular area is impossible to do that way.

(Question) - Visualize a 4' x 8' area with numerous pipes and no uniform pattern. Packing with rags is about the best you can hope for. Paul, in your problem what did you use out there?

(Answer) - Power brushing using Comet, a very unsophisticated method. We were taken by something the Oak Ridge people used comparable to the Radiac wash agent.

(Question) - Doesn't using Comet raise the chloride content of the water?

(Answer) - I'm sure it would, but in our case we weren't particularly concerned about that. We tried scouring pads, Brillo pads--none of these things did very much.

(Question) - Harry, at Chalk River did you try anything different?

(Answer) - No.

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At a meeting this morning, some of the people believed that as we discussed decontamination of the containment walls, using foam, spraying it and letting it set for several hours and then hosing it down might be a possibility.

We've had excellent results cleaning TRU contamination of painted surfaces using a commercial product called Mox. Rocky Flats Plant recommended it to us several years ago when they used it extensively following the fire at their plant. They had excellent results. I don't know how it compares with the Radiac wash.

We've used "Fantastik," believe it or not, by the case and have had excellent results. It's very good on pipes and helps cut dirt film and oil. Most household products used for bathroom cleaning will work well.

One thing we did use on metal was "old-fashioned" Naval jelly to clean up a lot of floor drains. By using a long-handled brush, we were able to apply it and allow it to set for a while, and then wipe it off with another long-handled brush with a rag on it. We were able to wipe it up and cut down the beta and the doses considerably.

We have many people to thank for all the help they've given in this thing. It has taken a lot of manual labor. So many things were going on simultaneously, trash removal, sorting, etc. We might have been getting two entries a day at an 8 hr. shift. Due to conditions, a man could go in for 1 hr. 45 min., then have to take a break for an hour.

We established early in the game that we'd send no crews in there unless they had experienced supervision with them. The size of the crews was set at five men with one supervisor. It has worked out real well that way with the total of people we have and the rotation and putting them in when they're fully suited up; they get a little exhausted after a couple hours at 90°F. We decided to brief every operation prior to going in both verbally and sometimes pictorially so each member would know exactly what to expect. Every new Met-Ed system volunteer coming onsite, even though they had their radiation work permit training, were indoctrinated with a 4-hour program on decon with Vikem. We then put them in a dry-run area (a clean area) where they'd be suited and could go through their operation. Once we got enough volunteers through this program, we always tried to have some who had been in there

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previously to go in with the new ones. Today we have all returnees coming back, so we're not confronted with that problem.

The volunteers came from other utility divisions. They were Met Ed employees, linemen, meter readers, you name it--99% of them had never seen a nuclear facility before. We've got a return rate of 96%. They get the same base pay as they would in their regular jobs but they get travel to come down here and overtime. The base pay is the same. You wouldn't think there'd be that many volunteers that would dress in coveralls in 90° temperature for 10 hours a day. It was their company that was in very bad financial trouble early in the ball game.

We have a total of 170 volunteers we're cycling through. An average of 50/week through gives a pretty good reserve supply to pull on. The dose rate averaged (May 30-June 30, 118 people cycled through) 84 mr/man. The total man rem expended today by the Met Ed volunteers is 32 man rem. The rate has continued to go down due to good techniques, good supervision, good spirit, people want to get the job done, and of course decay. There was good cooperation by everyone involved. Someone was in there all the time. About 2-3 entries were made per person in an 8-hour shift. We get more now because they're out of masks. When they were not making an entry, they were not just sitting around; they were out picking up in noncontaminated areas.

(Question) - Are these dose rates acceptable with NRC radiation guidelines?

(Answer) - Way below that. The administrative limit of the plant is 1R/quarter. We've only approached that a couple times and that's Vikem people doing hot jobs. When you approach 1R, you have to request for additional exposure that'll take you up to 2R per quarter, provided you meet the 5N-18 criteria. We haven't had a request for over 2R. The highest exposure has been 1475 mr. It's really remarkable when thinking of the fields we've worked in. It's hard to believe.

We've found it advantageous to have an ALARA man assigned to the decon group at all times. Any time that we're going into an area, we talk with him and he gives us his requirements. We also have an HP man, supervisory type, who works with the decon group. This has helped us in decon and scheduling and programming and production. They are liaison between the site HP organization and the ALARA organization. We have a meeting each morning with ALARA, HP, decon personnel and one of the

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GPU supervisory types and we discuss plans for the day, what has been accomplished previously and what problems are staring us in the face--so everybody on this team is closely meshed. We've found that it has paid off. This is not the site plan of the day but the decon plan of the day and we have it each morning.

The Vikem supervisor goes in with the team and they work along with the men. His exposure is maintained the same way. We set up our own control program in addition to the site's. Every day we have two clerks who read the attachments sheets and we keep track of everybody's exposure. We know at all times what a person's exposure is to date. The Vikem supervisor cycles in and out with the crew. He eventually is accumulating doses where the workers come and go.

If you'll remember, the averages the Vikem doses were quite higher. During the third quarter, which is representative, the Met Ed personnel averaged 40 mr, the Vikem people averaged about 250 mr for the same period of time.

The first time we went in the Sample Room, it was running about 17-20R/hr general area, gamma. The Sample Room is very small. We constructed a mockup sample room out of 2 x 4s and then just practiced, practiced and practiced on the mockup. We kept a log and after a while we were able to cut off 25% of the stay time, running two-man teams, one in and one out. Back in May, June and late April when we really had some dose problems, the crew that was going in would sit in front of the blackboard up to 2 hours for a 5-7 minute entry. We had the benefit of 8-1/2 x 11 drawings of floor area building layout. We used them extensively. Even if a man was going to just walk in a corridor, he had vividly in his mind exactly what he'd be going through to get there and knew what he'd be doing once he got there.

One method used was to put signs up "stand here" not "don't go over there." It was more applicable to show where we wanted them to stand. We had an 8-1/2 x 11 layout of the 281 level which was updated daily as to general area levels.

In one area there was a radiation field of about 2-3R waist level and only 50 mr topside. In this case, the supervisor went in with the crew and sat on top of a 12 foot ladder where he could direct activities in only a 50 mr field. There was no need for him to stand around on the floor in the high dose area.

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We have a very good company photographer who came out and took pictures of anything we needed. With these pictures, we could train people or use the photos to show to people who weren't working in there, but who could give advice on what to do. We have this album back at the plant. It's quite full now and it really tells the story well. This individual was a Met Ed employee who volunteered for the job. He had never been in a nuclear plant before and went everywhere. We gave him a quick training program and put him in a bubble suit and he took pictures everywhere. We had the benefit of Westinghouse videotaping our activities and we used these tapes for training the original Met-Ed people. In the ensuing weeks, we had the benefit of very good videotapes of actual decon work in progress. We had the capability of stop-action in the tapes so we could point out mistakes to the people, etc.

(Question) - Have you considered the use of a portable, shielded cubicle that the supervisor could sit in so he could be in visual and audio contact with the crews? Would that be of any benefit once you get into the main building? A control booth of this type would enable supervisory personnel to remain in for the duration of the entry.

(Answer) - We tried to develop the confidence of the Met Ed people with us--I wouldn't feel comfortable telling them to "go over there, and I'll stay here." They looked to us for leadership and guidance and if I'd have stayed back and told them to do it, we would have lost some of that closeness. It's a team effort by everyone. We worked together well. Essentially, when they go, we go. When we go in the containment, however, we're going to need a better communication system between the workers, the in-plant supervisor, and whoever's monitoring outside.

(Question) - Did you find a better way to communicate in there?

(Answer) - We've communicated by writing on a pad. The proper glove size helps there, because when you try to write on a pad and the gloves are touching the pad before the pencil, it's hard to write legibly. Many times, I couldn't even read my own notes.

(Question) - What prevents you from going to radio communication?

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(Answer) - It was never proposed to us, as I know of it. One idea, when these men go into the containment, we all say "let's use the TV to see what's going on." There's no reason why we couldn't have a TV screen in there for the purpose of passing messages.

(Question) - If communication is a problem, why don't you do that?

(Answer) - It is no longer a problem because we're in the auxiliary and fuel handling buildings without respirators now. In the early stages, it was to get in there and get this knocked down as quickly as possible with the supervisor in there with the people within sight at all times. You start putting a bunch of communication systems on them in the beginning, and they have all these lines to drag around with them. Our air supply wasn't that great in there to start with.

We have used radios. In the annulus job, we set up a control point in the trailer and we had people stationed at various levels and through radio communications we could direct turning the water off or putting the mist off, etc. We have used radios in our decon efforts, i.e., one man with a radio in the group.

We had small areas that we would attack and we would go through a big briefing before. Everyone knew that "if you were going to carry the Radiac wash, I'm going to do the scrubbing; if you're going to pour, I'd scrub." We'd back out and the next two guys knew they were going to go and wet vacuum. One man would pull the can and the other man would use the hose. We were briefed on every job beforehand so communication was kept to a minimum.

OK gentlemen, I know that we have no formal agenda as you know, we are here anyway to learn and to present problems that we had what we faced, I don't know what anybody has to suggest but that could make our job better, but we certainly want to listen. So, if anybody has any suggestions on how they would attack something, please feel free to speak up. I would like to point that one degreasing agent that we found quite helpful is something called Okite Swift. This is a principally methyl chloroform with a small amount of tricalcium phosphate in it. You can put it on with rags. We have found it effective for decontamination work. It is basically a non-flammable chlorinated hydrocarbon degreasing agent. The oil we found in the building was from

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the limit torques, valve hand cranks, etc. that leaked, and items like this. In containment, I would guess that the high water has entered a sump oil reservoir which was open, and has drawn or displaced some oil out causing oil contamination.

Paul, how do you handle things like electrical panels in terms of decontamination? Have you found anything very effective in getting them to decontaminate? We have a program set up right now for getting into electrical panel, cubicles, etc. We really haven't got into any extensive deconning inside those areas as yet. And we did smear surveys in all of them, in every box in there and one lesson that you learn is to keep your covers tight, if nothing else, don't leave them ajar or loose. We have smears up to 100,000 dpm gamma. Freon 113 might be helpful in decontaminating them. The electrical buses are on the 305 and 328 levels and have contamination on them. Many of the buses won't be able to be de-energized because of plant conditions. But if there is a spare breaker, it is a case where you want to use a Freon bath, clean it all up then insert that spare breaker back in and continue.

(Question) - Will a lot of these have to be deactivated until they get on some sort of a schedule for long term cooling?

(Answer) - Yes . . . intuitively with any of these smaller items, like electrical sockets, instruments and things of that nature from the size standpoint, decontamination analysis would show one way or the other whether these items could just be thrown away and replaced as opposed to cleaning them up. It may cost you too much money and man rem to clean up as opposed to just throwing them away. You know non-contaminated, clean and releasable. Like a small breaker, say a 400 volt breaker. I think these could actually be racked out and I'm sure a bath could be constructed.

But I'm from the old school, volume reduction. Don't throw it into the waste burial if you can put it into a garbage dump. Some day we are going to need that space to bury something that is radioactive. If we can clean it, let's clean it and get rid of it as non-radioactive.

We have set up a Freon degreasing unit that we use, we have an Electricon unit and a Freon degreasing unit to support our activities, and we can put electrical components through them. We degrease and decontaminate them and bring them out

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clean. They are sent back in for re-use. We are looking into a possibility for decontaminating some of this electrical equipment. They also have a process out now that you can bag an electric motor, run Freon through it while it is running and it takes the contamination out of it, it decons it, the only thing that you have to do is re-grease it when you finish. These, for instance, like a quarter inch pistol drill, we just take it over into our decon trailer and we put it into this Freon bath, we run it, we spray it, we bring it out and send it back in, it is clean and it is releasable. This has been advantageous to us in that respect on all electrical components of radiation survey instruments which are contaminated. We have taken them down and decontaminated them internally and externally. It does not harm the components inside whatsoever. They come out and they are operable again. Do we want to talk on that, any problems? We have had great success with this Freon degreaser, it will show you under different lighting whether or not you have removed all the grease, whether you still have an oil film on it, and possibly needs a little more bath time. We are also working on furthering the advancement of cleaning hoses. So far, the cleaning of hoses and cable looks very good. In a session this morning, they talked about the fact that there are miles of electric cable in the containment that have to be removed. That is something that has to be dealt with, whether it be able to be used again or not. But there is one method that is possible; you put in one end of the tent and pull it out the other while it is being sprayed and cleaned you go through a spool to spool transfer. Because you have an insulated coating on the exterior (most of that cabling is a smooth finish) if you can run it through a Freon degreasing unit, spool it in, put it through a degreasing unit that has a brush system set up, pull it on through, roll it up on the other spool and take it on out, you can save yourself a lot of money. Not only in waste generation and transportation, but you can also save money in selling that copper for salvage instead of burying it. Bear in mind that even as severe as this accident was and the contamination was, that when the manufacturer wraps up cable, for example it is wrapped up so tight on that wheel, that you could have a million DPM on the outer layer and the other three or four layers are a few thousand DPM. Most of that will be transmitted in handling more than anything else and where we had originally anticipated disposing of a significant amount of cable, I believe that the quantity we have removed so far is insignificant. This cable was on reels in the building; it was taken into the building in the early days. We had quite a few cable reels that were half full. Very, very early in the game, we were dealing with some smearables in

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the millions of DPM. We would pick up a skillsaw or other tool which had been laying right down in the mud, it was disposed of. We set up a pad with signs for anybody traversing through the area. The pad was used to drop tooling that they might have, socket sets, etc. We used that pad as a feed station to the electro-con/Freon degreaser. The night crews would then empty the pad, double bag the tools, get them over to the electro-con where we had a receiving station set up. They went through the electro-con and Freon degreaser and then right back to an adjacent pad near the tent. So we had a round robin going. It really became an effective contamination control mechanism. If we had an individual working with a hand tool for example that may have become contaminated to 30-40,000 DPM. The man dropped it when he went out, and then when he was going to go back in a couple of days later it was sitting on an adjacent pad either with fixed contamination on it because we couldn't get it all the way down, or in some cases, it was green tagged. That was the cycle that we used once we started dealing with tolerable levels of contamination. The pad itself was self-explanatory once the construction crews and employees got the gist of what was going on. This system avoided the need to go around the building and retrieve tools. It worked out very well. We set up an inventory too of everything which we brought out of the building. We deconned material which still had fixed activity on it, but it was low level. We stored all this equipment and tools and inventoried every piece of it so that when construction wanted to go in and perform a function, they would come to us and ask what was in storage. For example, material that was reused with low level fixed contamination included lead bricks, cement blocks that were left over, wheelbarrows. The radwaste panel located on 305 level of the auxiliary building is a panel which the operators have to get into about hourly. We completely deconned the panel and the area around it and tented it. When there is a ventilation problem, that tent will suck in; this immediately alerts us to take corrective action. I would like to cover some of the things that we maybe could have done better. One case is staging that was brought in with rust and scale. This should have been sand blasted and painted prior to use. In another area, wood gets a spill on it and it is lost. One other big thing is sleeving. Of all the hoses, air hoses, water hoses, and so on, we saved a lot of hose by sleeving water and air hoses to minimize contamination. Also with regard to chain falls; if they are contaminated there is no way to save the chain. When the chain went up through the gearing, it was lost. With regard to tools, use of more expensive chrome plated tools in lieu of tools with a porous cast surface, represents an important reduction in contamination. Another area is to assure that the various

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types of electrical cords to be used are a type that can be easily decontaminated. Another suggestion is: when you bring products in, don't bring the wood box in with the wrappings and the excelsior. All of that material then has to go out as packaged waste whereas if it was taken care of properly there would have been much less waste. All solid waste to be removed from the building must be LSA (low specific activity) boxes. The boxes are 4 foot by 4 foot by 8 foot. A plastic liner is put in the box for water-tightness. The box is banded twice around long ways and three times around the top. So far we have shipped out about 750 barrels of compactible waste and 50 of the LSA boxes. There is a total of 80 LSA boxes since we started collecting it. Much of this material could have been salvaged if it had been looked after properly in the beginning. The cost to ship and bury a barrel out to Washington is \$67.00. This includes the price of the barrel.

The eight methods have been used for decontamination in the auxiliary building; they are: dry vac, wet vac after Radiac wash, manual wiping, strippable coating, electro-con, Freon cleaning, hydrolaser and steam cleaning. With regard to the containment, the decontamination is going to be different from the decontamination of the auxiliary building. In the auxiliary building we could not use water when we would have liked to. Now, with the containment when we start going in there, the water processing problem will be gone. We'll be able to go in and use the hydrolaser for example, where we were not able to use it in the auxiliary building because we could not process the water. So, possibly we could go in and clean with plain water first rather than some chemical or try to wipe it up with rags and so forth. Now you're going to need some different methods than we have been using to approach this. The high access areas are going to have to be decontaminated, made accessible, just like we're doing in the auxiliary building in the corridors and the passageways. We're going to have to decontaminate them and hold them down for exposure purposes and other reasons. As far as the inside of the containment, we have to remember that the majority of the containment is not concrete, it's steel. There is some concrete down on the 280 level. Most of your operating level and so on is a grating. You have some shields which are used up on the 328 level, those are all epoxy coated. I think the only access you are going to have on concrete is when you come to the airlock when you come through the equipment access. You come out of the concrete floor onto the 305 level, but once you get up above that level, there is no more concrete, except the stairways, elevator and the Drings. Leaching from concrete surfaces has been a problem which we have not solved to date. If it got to the point where the leaching kept

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coming out, we could possibly seal it in temporarily, by painting the surface with one color paint (say yellow). Then when that was dry, paint the surface with another color (say grey) then you could treat the area as a clean area until the yellow starts coming through at which time you know you are reaching the point where the contamination could be coming through. Should you have an area that you couldn't get clean then you could do everything in your power to try to get it decontaminated and if you couldn't, you could go to a multicolor coating on the surface. There are different things we have tried to apply to the concrete to draw out the contamination from the concrete; we haven't had much luck with any of them. I don't know how to stop that leaching except to just paint the surface. This has been standard operating procedure in other stations. Any coating we use in the building we must research to insure that the fumes will not do any damage to the charcoal filters. This is one of the reasons that we did go to imperial coating because there was a study made on it and it showed that during the application there is an odor given off, but it won't attack the charcoal filters. That is the only coating we have used. There are probably other acceptable coatings but we haven't done any extensive investigation in this area. One possible method for spot removal of leachable contamination may be through the use of localized ultrasonics; we have not investigated this. One thing that I would like to point out is that we don't attribute everything to leaching. Once an area is deconned, it is good practice to use step-off pads. This is one area in which we have had a problem. We have really had a lot of problems trying to keep an area clean and people continue to violate step-off pads. For example, the improper way they take off the bootie; they have one foot over the step-off pads, they lift it up and whatever particles fall off fall on the step-off pad and they will step over that one and their foot will be beyond the step-off pad and they lift off the other bootie and activity will fall down past that. And so it gradually moves on and on. I don't know if anyone has had experience like this at your facilities but it seems as though certain people are going to violate the rules. We have observed this on in-plant TV. I understand that some people walk off step-off pads thinking nobody is looking; if nobody is looking, away they go. And other people will take off just one bootie. Some people will run out of booties; instead of standing there or waiting or use some other approach, they will continue on because that is the last booties they have on, although they do have a set of rubber boots and a set of plastic boots to exit from the area. So this is something that should really be looked at and severely dealt with administratively or otherwise. I might mention in the terms of access in the containment, that we feel fairly confident that at least in certain applications that the air lifter, which I think other crafts use, is a very nice

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way to get people to higher elevations. They are fairly readily decontaminable since it is an aluminum based structure with smooth surfaces. It is also relatively inexpensive; 80 to 90 pounds of air is required for operation. There is another method that we used for the work in the decay heat valve room. To keep contamination to a minimum area where we had numerous step-off pads, we set what we call the "yellow brick road." This consisted of a covering of Herculite material on the floor. This actually contained the contamination and everybody walked on that. With regard to access to containment, I think what you need to do is set up yourself a very rigid control of the materials going in and do this from the start. If you open that building up and you are (for example) planning to work in a particular cubicle, you must set up a control of the tools and this equipment to be used. It has to be established initially that there has to be an area near the facility where you are doing the deconning which is a control point for tools and equipment. When a man enters he has his own wrench, hammer or whatever. You must log him in with that equipment; when he comes out, he should bring what he took in. This is because everything that is left in there is another decontamination problem. For example when we want to go in and pull cable for some of the systems which are going in we try to decontaminate that area first.

We will completely wipe down that cable run to prevent spreading contamination, so when the personnel enter, they can get the cable pulled in in a lot less time than what it would take if they had to be more fully suited out with anti-C's and so on. Coordination between the decon crews and the construction crews is another very important area to cover. You are going to have to build actual barriers some place within the containment since it is such a large volume. A common mistake is not utilizing reinforced plastic. We found out in the early stages to use the plastic that has nylon reinforcement in it; it stands up well. The nonreinforced material rips, tears, and loses its integrity.

(Question) - Speaking of uncoated concrete, have you considered using something called the vacublaster? Chipping off the surface concrete?

(Answer) - Yes, but we found it to be too slow. We have vacublasters and they're very effective, no question of this. In the areas that we're talking about, the amount of activity which was contained was too small to be of benefit. In the containment we may consider use of sandblasting, but I do not think this is viable due to the airborne activity.

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I think that if we could, a lot of the areas we could hit with a steam-jenny. We could have done a good job on decontaminating with it, we've got the jenny available, but we haven't used it as yet. Yes, we still have a lot of time. We're hoping to use it. We've had training with it. We've gone in and we've had a lot of crystallized boric acid in the area which we've had to go in and hand scrape and chip. Had we had the use of the hydrolaser, we could have gone in and removed the material in no time at all compared to use of scrapers and shovels.

There are studies going on right now for use of the water which we have put through Epicore II for de-sludging our tanks and flushing our systems. It hasn't been firmed up yet but that's one source of water we could use over and over and over again. Run it through Epicore II, we're not generating any more water. There is a proposal that involves a series of small filters to desludge tanks. It's a portable rig basically we could take into the building, vacuum the mud out of the respective tanks direct to the filter equipment and into our hydroblasting machine, reusing the water. You should appreciate again the situation of the site and the work required to get permission to utilize something like that.

I'd like to thank the DOE and Bechtel for getting us all together. Thank you very much gentlemen.

HEALTH PHYSICS PRACTICES FOR DECONTAMINATION

DISCUSSION LEADER - WALT RUHTER (GPU)

Health-Physics Practices for Decontamination

Discussion Leader - Walt Ruhter (GPU)

(Discussion Leader) - We shall attempt to cover two general areas: (1) criteria, and (2) personnel protection concepts.

Criteria

If we are going to decontaminate something, we must know whether it needs to be decontaminated and to what level. The health-physics people are the ones to determine this. There are different standards around the country and different ways of implementing them.

From the standpoint of surfaces - whether the floor is clean or dirty - some plants use a criterion of 1000 disintegrations per minute (dpm), some use 200 dpm. There is the problem of release to the environment, but there is an ANSI standard that covers that. The standard has been revised for easier implementation. Then there's the question of soil. If you think you've got some contaminated soil, is it actually contaminated, and if so, where do you put it after decontamination?

For our plant we're using 1000 dpm and an exposure rate of 0.4 mrem/hr. We're in the process of changing that, and we're arguing about what we'll change it to. We're definitely going to 0.1 mrem/hr, but we're trying to decide whether to go to 200 or 100 dpm, and different numbers for smearable vs. frisker surveys.

(Comment) - You have to consider the impact of your 0.1-mrem/hr limit on your frisker survey.

(Discussion Leader) - Let's divide this into smearable or removable vs. fixed contamination. To determine whether something is contaminated, you can use either a smear or instrumentation. If there isn't any smearable activity, there may be some fixed activity.

Let's look at it from two points. First, release to an uncontrolled area vs. surface contamination. If it's 100,000 dpm, you've got to do something. The most common criterion now that I know of is 1000 dpm/per 100 cm². That's smearable (beta-gamma) contamination.

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There is a new standard that gives "deminimus" type of numbers for manufactured things and has been used in nuclear power plants as well. It was written by Alan Brodsky of the NRC. The major change between revisions 0 and 1 was the acceptable skin contamination limit of 10^{-2} Ci/100 cm². There are still limits there for manufactured articles that the NRC has already established.

If there's a standard that's accepted and "implementable," that's what ought to be used. That's part of the problem with the ANSI standard. It has been in effect about 2 years now. The newest revision is maybe 3 or 4 months old.

(Question) - What is "background" and what is contamination in view of that? I'm still wondering how soil contamination is a problem here as a result of this incident. Did you take baseline soil surveys and have now taken some more, and based on the releases you think you might have contaminated soil?

(Answer) - If you spill a contaminated liquid on the ground, you've got contaminated soil.

(Comment) - Where I came from, contaminated soil was not an unusual problem in a fuel-reprocessing plant.

(Discussion Leader) - I think that the basic health-physics problem is the decision you have to make when someone asks, "Is this piece of equipment contaminated?" You have to make a decision about sending that item out into the world. Or you've got some soil you've spilled some liquid on, and you can read 90 counts per minute on your HP210. Is that clean enough? What's the background? About 50 to 60 counts per minute. Have you done a soil survey on it? Well, I've done that. Why don't you take a sample to the lab? Whatever a health physicist does, he's got to have a number. Can I leave it, or do I have to pick it up and cart it off? Is this piece of equipment clean enough to send away, or should it be decontaminated further?

There are also other aspects of this that are covered in Regulatory Guide 1.109 and Standard Review Plan 15.7.3. There are some bioaccumulation factors that may need to be considered. If you say this soil is nonradioactive and you plant a certain type of alfalfa, or whatever, it will concentrate that particular isotope, and when

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the alfalfa is turned into foodstuff, you could have a higher concentration. So, you establish backgrounds through the Regulatory Guide 1.109 process to get an entry. Standard Review Plan 15.7.3 is for a rupture of a radwaste storage tank.

If we say, "this is an occupational surface, this is an occupational exposed room," what kind of contamination can be tolerated on this surface where we're shuffling papers, etc., without reaching the occupational exposure limit of 500 mrem/year? There is a lot of activity you can tolerate here from the standpoint of resuspension, inhalation, etc. It's 50,000 dpm. I suspect that running back through that kind of concentration reveals that contamination is not zero and it's not twice or three times background.

I'd like to zero in on the question of picking up soil from a contamination control standpoint. The soil is inside a protected area. We're monitoring exposures and all that. From a contamination control standpoint, we just can't have it lying around on the ground. That soil will have to be removed because there will be some construction in that area.

You'll have to dispose of some of it as radwaste. How much, is a good question. If you can decide what the number is you've got to clean down to, you can decide how much is going to be radwaste. It's essentially the same as if you had a contamination zone inside the plant. It's the same whether it's a concrete surface or a dirt surface.

In the Department of Energy, we used the ANSI standard, which is 200 dpm on a smear that is counted in a counter and is nondetectable with a frisker (1000 dpm can be detected with a frisker).

(Question) - What ANSI standard are you talking about?

(Answer) - The one issued for comment in August 1978. It has now been published N13.12-78.

(Question) - Is that the one that gives recommended limits for uncontrolled release?

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(Answer) - It's not quite so stringent on the kind of instrumentation because people couldn't measure levels as low as some of the numbers in there. This is in a smear counter with the frisker running over at a "snail's pace" (0.01 m/sec). It's calibrated to detect 100 picocuries. The standard does allow spots three times this number over a square meter if the contamination is less than this on the average.

(Comment) - Why not relate that to what you would have to use for shipping - that is, the limits that would be allowed on the outside of the package? Use your environmental impact statement as your guide for releases off the site.

(Comment) - There are two documents that Jack Healy put out several years ago. Those models might be worth looking at. He was dealing specifically with contaminated soil, trying to relate back to doses received by people. One of the publications deals with doses delivered to people, and in that one he has tables for every isotope. Then there's a separate document that specifically addresses the soil subject. It might be worthwhile checking the rationale and thought process he went through to see whether it is applicable to our case.

I was at a meeting a while back and was under the impression when I left that the NRC was talking about unrestricted use. The statement made was that the NRC was considering pathway analysis on a dose-commitment basis and a 5-mrem/yr dose commitment.

(Comment) - You do the pathway analysis and back calculate; that's a big job from my viewpoint.

(Discussion Leader) - That's the reason his question is so pertinent. The only time you have a soil problem is if you're tracking the contamination around on your plant site. If it's causing you an operational problem, you ought to do something. You should clean it up or cover it. In terms of relating soil contamination to a problem, it generally needs a pathway analysis. That's why I asked the question, "Why worry about cleaning the soil up until you decommission the facility?" Until you start planting something in it or resuspending it, the soil must be managed in some way before it causes a direct problem.

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Let's relate that analogy back to the plant where you're wandering around in the hallway. If we did the calculation on the level where the contamination became a problem. . . . From a health standpoint, tracking around the plant is no big deal. If you've got a couple of hundred counts per minute lying around on the ground, that's no problem from a health standpoint. The exposures from that kind of contamination are trivial. But you just can't run a plant that way--you don't know whether it's 100 or 200 dpm. It's too late when it starts showing up on the floors of the local bars! If you're tracking it around, you've got to deal with it. At that point, any level's a problem.

We've already gone through one fire drill like that at TMI when SAI contaminated its trailer.

When the SAI trailer became contaminated, they were going over to the local motels and practically put a certain individual in handcuffs to take him back to see where he had been, because they were worried that he had tracked some contamination off the island. I think the best term for that one is a health-physics riot. That's exactly what happened. There was such an overresponse. It's because of that kind of psychology, where almost nothing is acceptable. If you can detect it, it's too much.

If that's the kind of world we're living in, and in many situations we are, there's your criterion right there. You don't have to go any further. If you can detect it, you clean it.

That's basically what we were told by the NRC.

(Question) - Do you have to submit criteria to the NRC?

(Answer) - The NRC reviews everything. If we prepare a procedure, they'll review it. If you pick a number, 1000 dpm, and they say "ok," you've got it. They've said "ok" to 1000 dpm for general criteria and a lot of plants use that, but then a lot of plants use 200 dpm.

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(Question) - What do you set your portal monitors for? Should you be using them as a device for checking people? Now that you have them in place, you probably won't be able to get rid of them, so the question is, doesn't the NRC ask what good they do? What level do you set them at? How do you calibrate them, what's your criterion?

(Answer) - They haven't asked yet. We frisk before the personnel leave the work areas. The portal monitors are really a pretty gross check unless the device is sophisticated. The real problem is, if a person has gotten to the portal monitor and is found to be contaminated, then there is a problem.

(Comment) - You will have some stuff that you'd want to put in a landfill rather than treat as radwaste. Then comes the question--what's the segregation point?

(Discussion Leader) - Anyone have any comments on 1000 vs. 200 dpm on surfaces in the plant?

(Comment) - Consider the number of man-hours and figure the difference. That's a very real consideration, and that's largely the one we're in the middle of.

(Comment) - 200 dpm is certainly harder to determine in a field. If you've got an instrument with a 20-count/min background, a 200-dpm level is no problem from a technical standpoint. I think the point is that if you've done enough smears to determine that, and you've got a building that's 500 x 100 feet, then you've got a big job.

(Question) - Is there a difference in monitoring techniques? What's the difference in using friskers totally and smears to determine contamination levels on plant surfaces?

(Answer) - You have to use a combination of the two. You use the friskers to find the hot spots. You can't find those with a smear. The people who take the smears get the reports back, and they're the ones who make the meter readings. Once you get some sort of feel of what the smear is and what the instrument reading is, then you can take fewer smears, but you still take them for spot checks.

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(Comment) - If you've been working a while, and you don't have significant skin contamination on the people working there and you're working at 1000 dpm, you can leave it at 1000. If you end up with a lot of cases of skin contamination, spending a lot of time and effort to clean up, then you must think of lowering the number so you can reduce the amount of material that is resuspendable and can contaminate the skin.

There may be other factors involved in that. It may be purely a matter of technique. I don't think you can use the activity as the only measure and use skin contamination as that gauge.

(Comment) - If you have strontium-90, and you have a couple of hundred disintegrations per minute, over the area of the intake tube you normally use, you would exceed 25 mrem/wk on the skin. Let's get back to how you want to set those totals, too. At 200 dpm, if it sticks on the skin (strontium), it is going to give you an exposure to worry about in the outer dermal layer of skin. If you have two standards, one for skin contamination and the other for surface contamination, then I guess there is no "magic" resuspension factor that we can use. They all need to be tied into each other and you need a coherent program to get you back to "how much skin contamination do we have, and how much can we tolerate?"

(Discussion Leader) - Is it the consensus that 1000 dpm/100 cm², measured by frisker or smear, is an easily attainable and reasonable number?

(Comment) - Is that your last line of defense for things going out the gate? Nonanimate? Then you have to make that in-plant limit your offsite limit if that's your last line of defense.

(Comment) - Is it practical to have that as an offsite limit? Or a limit for release to the public? Surely you have some mechanism that requires an additional piece of paper for something to go off the site. A second check. In other words, you can leave it sitting around your house as long as you want, but if it goes off the site, it has to be checked again.

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(Comment) - There could be another control point established. You've got the inner perimeter, outer perimeter, check trailer, TLD dropoff, and the bridges. Maybe one of the last checks could be made before crossing the bridge. The guy at the bridge has to have in hand a paper that states it's ok to go across the bridge before he lets anything out. It has got to be surveyed back in the plant some place.

(Comment) - I don't think you want to wait till the bridge for the final check-out. What about the TLD dropoff?

(Comment) - I think as a minimum, no further than the security gate.

(Question) - Do you have a property release system for inanimate objects?

(Answer) - Yes. We have a green tag system. Right at the moment the criterion that's in our specs and procedures is 1000 dpm and 0.4 mrem/hr.

(Question) - And it goes out the gate?

(Answer) - That's right, in theory. In practice, that's not what we do. But, in theory, we could if we wanted to. That's in the NRC book of procedures.

(Question) - Are you talking about drummed materials?

(Answer) - For purposes of discussion, let's just talk about items that are not controlled in any way. They're not in drums. Let's say we want to send it to the sanitary landfill or home with somebody. We want to just forget about it. If we're sending it to a shop, we're still going to control it or make sure that he can control it. We can handle that problem. It might not be easy, but it's a technical problem, not an administrative one.

In the sense of turning something loose, if we're going to decontaminate it, we want to get rid of it, and we want to decontaminate so we can get rid of it.

(Comment) - You're just talking about exterior surfaces?

(Speaker) - Any accessible surface.

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(Question) - Is anyone using liquid scintillation for gross beta counts?

(Answer) - There is a gimmick some of the guys use. They take a piece of styro-foam, the kind that is available in various shapes for absorbing shock, rub it around, and throw it in. It dissolves, and you get a beta count.

Back in 1966, I published an article which discussed 25 different kinds of filter papers and the quenching problems with tritium. It turned out that the Whatman was the worst of all the ones I could find. In the normal solvents used for liquid scintillation, a lot of them become essentially clear. These are commercially available through Whatman and Gelman. I listed the wet strengths, the quenching problems, and the long-term problems of having to keep them in the solution for the measurement of tritium. A lot of filter papers are available, and you don't have to make them up yourself. You can get down to not too many dpms. The question with tritium is, "What do you want to get down to?" I don't think that the cost benefit works out down to 200 dpm for tritium. In fact, I would say a larger number, maybe 5000.

In the ANSI standard, this 200 dpm is for strontium-90 and a few other relatively hazardous isotopes.

At Laurel we were doing biological radwaste that had tritium and carbon-14. We were doing smears with Millipore filters and liquid scintillation and had the counter set up for a tritium channel. We had another channel set up open just above the tritium, so you could see everything else (gamma and all).

(Question) - How much tritium do you have? Significant?

(Answer) - Not that we know of.

(Comment) - Later on we got tritium in the water in the tank.

(Question) - What's the plan on that airborne tritium? Containment air samples?

(Answer) - We've got a number of containment air samples, but I'm not sure how good they are because we had water in the sampler, and that's going to plate out along

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the sample line and probably going to distort the tritium count. We've definitely got tritium in all liquids coming out of the containment building, behind the cesium and strontium that we've got.

The numbers that they recorded in the air sample were in the range of 10^{-7} to 10^{-8} . Those could be quite a bit low because of the water. The samples are going through long lines. They may have the same problem.

(Question) - Where is your sample collection in relationship to the end point of your sampler?

(Answer) - Eleven feet. Some of the tritium that was in the air didn't get to our sample box. At the 626-foot penetration, there was water in the lines all the way down. The guys had to pour out a couple of drops of water after they had done the gases. You have to immediately suspect the results. What I'm saying is that the 10^{-7} and 10^{-8} that was measured in the sample box could be low. It would be interesting to see what the tritium was in the drops of water.

(Speaker) - We didn't get any of those drops of water. They were poured out!

(Comment) - On the tritium it's going to be water anyway.

(Discussion Leader) - I'm saying that if you take the water concentration and go through this partial pressure evaporation type of mechanism and calculate the equilibrium in the air down there through thermodynamics, the concentration should be about two orders of magnitude higher than what we measured. In other words, it should be about 10^{-5} rather than 10^{-7} .

This sample was at 626-foot. There's water in the air. It should be pretty much the same throughout the building. The data we've got to date should be considered suspect because I don't think we have a representative sample yet.

(Question) - What do you base your assumption on, that there's no organically bound tritium left in the containment?

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(Answer) - I didn't assume there's no organic, but I said there's no free gas vapor.

(Question) - Are the decontamination criteria that we've got to use (the ANSI standard, 1000 dpm/100 cm²) tolerable from a working standpoint?

(Speaker) - We've got floors with a count of less than 1000 dpm already.

(Question) - Didn't you say there's seven-tenths of a percent of H₂ in the air yet?

(Answer) - Somewhere in that range.

(Question) - Shouldn't there be some tritium in there?

(Answer) - Possible, but not probable. I think one of the things that happens with tritium is that it "likes" to be water better than it likes to be H₃.

(Comment) - I don't think it would be preferential; whatever percentage is in the water, it's in the air, too. If there's free hydrogen, there's tritium.

(Speaker) - There's not much argument on criteria. If you can decontaminate it, you can get it to 1000 dpm. If you can't decontaminate it, then it isn't going to be 1000. If it's removable by smear, you ought to be able to decontaminate it. The only other thing to get into there is leaching.

It's certainly a function of the period of time the water is going to stay in the containment building. When we're down to worrying whether it is 1000 or 10,000 dpm on the floor, we'll be in good shape.

(Comment) - What was the basis for deciding the limits? Somewhere along the way, you have to compare them to what is reasonable as far as background goes and what is allowed for shipment. I think you're going to be too restricted if you go 1000 dpm. You can drive down the highway with a package that has a contact dose rate of 200 mrem/hr, but I'm not sure you'd want a 200-mrem/hr reading. You've got to look at the basis. You've also got to look at your environmental impact statement as to possible pathways. What level of contamination would be allowed in your soil and vegetation? How many people are using the area?

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(Comment) - For the DOE, we use 200 counts/min for a pancake probe. Maybe 600 to 800 dpm. We use 200 for everything except working areas.

(Comment) - We probably do things a little differently than most of you because we use 900-cm² smear paper to start with. We wipe a whole lot, and put it in a probe and look to see whether we find anything, on a 5- to 10-minute count. We don't have zones. The only time we put shoe covers on in our lab is when we clean up something we've spilled. I wouldn't say you could adapt that to your situation here--I'd be the first to tell you that. Our standard procedures require that anything smearable be controlled in some way.

(Discussion Leader) - I think that is common practice at most places. You have criteria. Anything smearable is cleaned up. Anything potentially smearable is placed in zoned areas. That put you down into that 200 dpm because it was smeared with a pancake probe. I think in a lot of facilities there's a difference between criteria and what they operate on. That may be the problem with the way we do business at TMI. We can set up criteria, but I think we ought to continue on the basis that if we find something, we clean it up.

We've got a lot of areas where the contamination levels are less than 1000 dpm right now, but we still have to wear shoe covers. Staying on respirators was easy because we had done that for so long.

Personnel Protection Concepts

(Discussion Leader) - What kind of techniques are being used for protecting people doing decontamination work from a health-physics standpoint? This morning we had discussions about respiratory protection, whether to use the biomarine pack or Scott Air Bags or respirators--the pros and cons there.

What about health-physics practices in relation to the NRC? I think you have a big question as to whether or not you want to allow someone to get mildly contaminated or to have a heat stroke. You have to make up your mind. We were talking about the Beta-guard material this morning or using a wet suit when working in a wet environment. That's a very real concern.

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What about that Tie-back material? Tie-back is a strong paper used to cover all kinds of things. It's thin stuff, so from a beta-protection standpoint it doesn't provide much. It provides little protection for water. It's splash protection--not immersion protection.

If you have some more expensive beta protection, such as Beta-guard, you'd want to use paper Tie-back over that to prevent the beta protection from getting contaminated so you can use it again.

One of the concepts we talked about for long-term cleanup, once the sump water is processed, was using the tritiated water for wash.

One thing in regards to protective clothing is keeping people out of masks. The questions that come up are the criteria, the resuspension factors you are going to use, and at what contamination level do you think that potential airborne activity may be a problem. Our guidelines are as follows: If you take a smear that reads 25 mr/hr per 100 cm², then you are required to use a mask.

We're using a number like 50,000 dpm. Other plants use values that vary between 10,000 and 150,000 dpm.

(Comment) - That can come about from what isotope you assume is the basis for that value. If you do it on the basis of strontium-90, you end up around 10,000. We had a situation where we had cobalt (probably one of the worst isotopes), but because of the difference in the MPC, we could breathe it at levels well over 100,000 dpm.

(Comment) - Initially we put large numbers of dosimeters all over the person. Then they got some idea of where the exposures were higher, and they still routinely put one on the forehead and the thigh and one on each hand in addition to the normal badge. They also then put on a lead apron. Rather than try to protect the whole body, they've protected the most of the body so that you're now in the extremities kind of thing. Then they're trying to clean the cell so that they can go in and work with minimal stuff. So they're buying some exposure in terms of tradeoff for the safety of the person from other hazards. At the same time they are trying to clean it down to a level where people can work without protective gear.

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(Question) - What kind of experience, other than at Argonne, have people had with the lead apron?

(Answer) - I think the lead apron was just what was available. It gives some gamma reduction as well, but it may not be all that useful. When you wear something like that, you absolutely must have some other dosimeters: we just don't see beta exposure under the normal badge because it's under the apron.

Usually our contaminated areas are now very confined spaces. If a guy is going in to do decontamination, either hosing an area down or running a vacuum cleaner, he's going to be facing the source.

If you wear a lead apron, don't forget that the rear of your body is exposed. Therefore one dosimeter is put in the back pocket.

A thigh dosimeter is used on the back of the thigh, and rubber boots are worn because water gets splashed. We've been using fireman-type boots that are heavy and therefore provide beta protection.

(Comment) - You must consider the ALARA criterion when you talk about lead aprons and other protective clothing. You get to that point where you have a guy in there to work for an hour because it takes him .6 hours to get in, and you put in one crew a day. You can use up a lot of exposure and wear a guy out, and not get much done.

The point is to clean up the cell and dress people to minimize exposure. You clean up a cell because you think that doing the work after it's clean is going to buy you quite a bit in terms of total exposure for the whole process.

That's the same situation we're going to have down here because reconstruction's going to be done, and a lot of construction people are going to be here, and we don't want any exposure for them.

(Question) - Just how effective is that apron in terms of the excess weight the person is going to carry?

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(Answer) - For penetrating gamma, a thin lead apron is not going to do much. It will reduce or eliminate the beta, but it would seem to me that that extra weight really reduces his efficiency and the time he can spend doing his work.

(Comment) - It didn't seem to me that they really had a serious beta problem in the context of the beta-gamma ratio. They were talking about maybe 1 R/hr gamma and 15 R/hr beta when they finally decided to go in--when they were done with the remote decontamination. Working inside a shield almost eliminates the beta.

(Discussion Leader) - It seems to me that we got 10:1 in the beta-gamma ratio. It wasn't enormous, but it was appreciable.

(Question) - Have you given consideration as to how you'll approach decontamination? Are you going to use automated hydrolasers?

(Answer) - That was the topic of this morning's discussion. But yes, where we can perform remote decontamination by hydrolasers, we will.

The numbers I wrote down after wet vacuuming were 500 mrem field gamma and 1 mrem/hr beta. Now, to me, when I looked at those numbers and I saw the way they were dressing those people, it sure looked like overreaction. You get contamination down to those levels, especially in hot cells, and we used to consider that clean!

(Comment) - I think it depends on what you're going to do in there afterwards.

Those numbers there would not be acceptable for us to go in and start doing reconstruction, at least not in my estimation. They'd have to come down further with toothbrushes, or whatever it would take. The point is, do you need all the protective clothing that they were using?

They're fairly conservative, but there are a couple of things. This cell had been used since the early to mid 1960s. When you're talking about something in use during that period of time, you are going to do a large amount of work on that 15-year cycle, and it may be worth doing something. One problem you're going to have when you start doing this kind of work is that your dosimetry badges will end up with low-level

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contamination that can give you "fits" as far as dosimetry. If you put a speck of something on a badge, near a detector, it can give any kind of a reading, depending on where it is, because those detectors are generally worn for different things. You assume it comes from the outside, which is not necessarily true if it's a gas that oozes in or a contaminated spot gets on it. Typically it's not an exposure hazard for the individual because I've taken fairly large numbers of contaminated badges and put them in a shield, with fresh detectors in them, and got things you could interpret all the way from pure beta to pure gamma, just depending on where and how the contamination was, even though the beta was causing the dose on the TLD. Very often, you see nothing on the second detector because, again it is beta and because of the geometry and the softness of the thing, it is essentially background on the second detector. That is a serious consideration because, when a guy unsuits, he's not going to take his dosimeter off last so he may be slightly contaminated. That may be part of their philosophy because over the long term that does cause you a lot of grief.

Two things as far as protective clothing: I don't know where or how Airline masks fit, but one of our requirements is no length of hose greater than 25 feet and also no hoses interconnected--it has got to be one solid length of hose. Portable manifolds are going to make a big difference as far as breathing goes. Another thing is, we talk about skin contamination. We had a problem with that in several areas. What we did was train people to provide undressing assistance. We found that was extremely helpful for areas with high contamination levels. It doesn't cost you any extra exposure since it's done at the stepoff pad. We trained them how to undress the guys that are coming out. When you're wearing a lot of clothing, like hoods, etc.

Back in the early days, Bruce Irving was telling me that they were counting outside clothing contaminated to a couple of million dpm. One of the problems was that some of the health-physics technicians, not knowing how to get these guys out of the superhot stuff, were contaminating the guy while he was coming up. I think we need good help, very good help.

I took a bunch of badges that we keep in boxes down to the whole-body counter and stuck them under, and, as you'd expect, they really do count. I wanted to find out which one, and that was really naive because the more boxes we took off, the count rate went up a little slower. A bunch of badges that are 15 or so years old show contamination all the time. If you leave those in the field for a month, the guy may

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not get any exposure from it, but the TLD sure does. We routinely take all the badges that come from hot areas and dunk them in a well counter for a short count.

I know Ira does count badges periodically. I don't know how often.

Regarding the layers of clothing, there is a lot of philosophy involved. If you establish two or three control points the man has to pass through, you normally try to provide him with that many sets. Then he has something to wear by the time he gets to the last control point. You usually provide him with something to protect against the wet climate and maybe a thin pair of coveralls under that.

(Question) - Which would you establish first, the number of control points or the clothing?

(Answer) - It seems like sometimes we've gotten into situations where somebody has predetermined that the guy needs five suits of clothing, and then I guess we'll have to set up five stepoff pads for him to come through.

(Question) - Why do you need five sets of clothing?

(Answer) - I was being slightly facetious. The point I was trying to make is that the first criterion somebody would set up was the number of clothing layers without a strong basis for it and without regard to the number of control points. Then they'll go back and set up control points and slowly eliminate this. If it's not done by setting up the control points first and then determining the clothing, you could have two control points, a minimum of one with a pair of shoe covers. That's the logical way of doing it.

We've found that we're able to get guys to dress down all the way to their underwear and then provide them with a paper lab coat to get to the locker room, eliminating that extra pair of coveralls.

(Question) - What kind of contamination levels were you working with?

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(Answer) - Fifty to 100,000 dpm. We had to teach them how to dress up because the guys would end up with balls of masking tape on their wrists, and it would take them 10 minutes to get unwrapped again, and they'd have it all over themselves.

(Question) - Does anybody, anywhere, use a criterion that states certain contamination levels require certain clothes?

(Answer) - That's strictly experience, but on things like your containment re-entry, you probably ought to have a criterion. I'm serious about that containment thing. I went in to SL-1 6 months after the accident, and we had three suits, including plastic, and when we ended up, we showered at least five times. We were undressed by other people at each step.

REACTOR COOLANT SYSTEM DECONTAMINATION WORKSHOP

DISCUSSION LEADER - DON HALLMAN (BABCOCK & WILCOX)

Reactor Coolant System Decontamination Workshop
Discussion Leader - Don Hallman (Babcock & Wilcox)

(Discussion Leader) - I'm Don Hallman from Babcock & Wilcox and this is the Reactor Coolant System Decontamination Workshop. Although no one has decided what our goal is today, I feel it is to get help from the various people that are here to find out what we should be doing in our RCS group. Generally I have divided us into three categories - the first category is the cleanup of the water which is in the RCS systems. That water is pretty highly radioactive. We need to clean up that water as best we can both to lower the general radiation levels in the reactor building and also outside the reactor building for the people who are going to move fuel and inhabit the fuel handling bridges and platforms over the fuel pool. The second category is the need for radioactive gas removal and clean up. The third item will be to decontaminate the Reactor Coolant System.

Our thinking at B&W has been more or less as follows--early in the game (we are not sure what the schedule was), we would rig up some way to control the decay heat; heat removal without the use of the steam generators. The water possibly could then be drained and processed, hopefully through the EPICOR system that is being set up.

There is one thing I'd like to caution you about. There is a wealth of experience on removing ruptured debris from reactor systems, but that experience is for reactors under their normal operating conditions. You can use as much of that background experience as possible but you must have samples out of TMI to check conditions and make comparisons. It's too easy to "start pulling recipes off the shelf" and saying they're going to work here at the island without checking to see if they're applicable to this accident.

Maybe just relating an unfortunate event from times past will help keep perspective on this. The first decontamination of our DR occurred in 1962. It was initiated when a magnesium-plutonium (magnesium oxide-plutonium oxide) fuel element ruptured in the primary system. But, the primary problem happened to be in the activating corrosion problem that we encountered. We thought we had the right process and knew how to go in and clean out that primary system. We were getting ready to start the process and checked it out on some of the materials. We found that the water chemistry was just a bit different. It would decontaminate, but the efficiency instead of being "25" ended up being "3 or 4." Fortunately, we were able to recognize this quickly and change the chemical mix after the first batch. We got the efficiency

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up to about a DF of "10" which was a pretty respectable number. The point is, we got overconfident, and hadn't checked enough before we started.

I think one of the biggest problems is that the decontamination process may dissolve the contamination too quickly and you're going to have some horrendous radiation problems when you start breaking it out. So, it's probably going to be a matter of keeping the concentration very low and having some way of handling these transuranics whenever you bring them out of the system. You've got some small amounts of plutonium and uranium and other things. They all have different constraints on how to be handled once they are out of the primary system.

We do have a lack of knowledge concerning the surfaces inside the RCS. Right now, we have no method of getting artifacts out of the tank. We have talked briefly about getting some artifacts out of the letdown system.

One of our goals is to select and retrieve artifacts as early as possible from the letdown system. This will give us a ball park idea of what the primary system probably looks like. One task area would be to drain and cleanup the reactor water prior to removing fuel. There is some suspicion that we will locate fuel fines (sand) around the system in various places where you would expect them to lay. The bottom of the reactor vessel is probably the most likely place. If there is any larger debris, it would probably be laying on top of the fuel. One way to start is to do the best on your homework before you start any processes. After the fuel is removed, the steam generator water is removed. Then open up the steam generators and pick out any loose debris. If chunks of fuel are found, there would be some concern. One of the things that you always have to worry about on the decontamination process is the problem of redeposition. That is what got us into some of the trouble in 1962 in the PRTR. That led to the low DF. We actually took the material off the wall and to the pipe but we either left it in too long, the PH shifted, or the temperature affected the stability of the solution, so a fair amount of the material redeposited on the pipe.

One of the insidious things about decontamination is that you can develop fine processes to give you 500 - 1000 DF in the laboratory, but when you apply the process to a reactor system you get a DF of 2. Then everybody wonders where you went wrong. Well you didn't go wrong in the usual sense, since the chemistry is still the

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same, but you may have had a different set of surfaces or different flow conditions (such as laminar in lieu of turbulent) and this upsets the whole ball game. Anyway, once you drain the system down, I would plan on going into the steam generator. For removal of debris, some type of mechanical means is required, picking out whatever you can. Then we would probably pull the internals out of the reactor vessel so we can get to its bottom.

I wouldn't expect decontamination to get the levels down where they're clean; activation would be the main problem. So there are probably some deep mechanical problems to solve if we decide to go that route. Vacuuming through 20 feet of water will take a lot of advanced planning and dry runs. It might be simpler just to pull the internals and have a clear look at the condition. It is also possible to back flush the instrument lines. The Reactor Coolant System is on the order of 100,000 gallons. So if we come up with multiple step processes, each step is going to generate at least 100,000 gallons worth of waste unless we find some in-line processing to use.

In all likelihood CANDECON is not going to do this. CANDECON, as I have read, is a weak chemical solution. During operation it may take out a fair amount of radioactivity, but it's not made to remove everything down to the bare metal on the wall. I don't know if anybody really knows. This situation is somewhat different from anything that people have seen before. You would expect most of the activity to be on the surface. The experience we had was that there was very little leaching of the material from the fuel. We managed to get our temperature down very quickly.

(Comment) - I'd like to address a couple of problems I think you have on the decontamination of this plant. One problem would be the 12,000 cubic feet of volume. It's not easy to get the volume of water necessary in there to rapidly sluice out the system. The only lines you've got are very small, so it would take a certain amount of field time, unless you want to cut into some of the very large Emergency Core Cooling Systems lines which are about 10-12 inch. We do have some decay heat lines which are about the same size. Secondly, in order to circulate water using the reactor coolant pumps, you have got to have the pressure up to several hundred PSI. This means you have to pressurize the system to some extent if you want to get good circulation. The third item of interest is the fact that the reactor vessel can't be drained, because there is no drain on the bottom. That is standard practice in reactor coolant

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systems. So the point is, you can't get in there fast. It takes a while to get the conditions necessary to do the job. Also heating could be difficult unless you use the secondary side of the steam generators, and then quickly remove the solution. So you have to be concerned a little bit with the long term role and effects. The solution is not something you put in there, run very shortly and then remove.

(Discussion Leader) - The incentive to cleaning this RCS out is to decontaminate those areas that need detailed inspection and refurbishment, and to keep the exterior fields from the interior contamination down to where they won't interfere unnecessarily with future operations.

You expect to have to work around reactor coolant pumps quite a bit. At a minimum you will replace the seals. I don't know if you will end up pulling the entire pump shaft, etc. for inspecting or not. You will have to work around the vessel head. You'll have to inspect the internals also, as the temperature in the core got rather warm during the accident.

(Discussion Leader) - Another thing to talk about is the cleanup of the exterior surfaces. Those exterior surfaces are all carbon steel with the exception of certain small piping which is stainless steel. At a minimum, all that mirror insulation will have to be removed and surfaces examined to see if there was any adverse effect when the building spray initiated. Those surfaces will have to be cleaned. My thoughts now are that a hand wipe may be the best method because it does not spread any contamination. The steam generator, the bottom heads and the pipes that come out from the bottom of the vessel and all supports have been submerged pretty well since the accident.

An alternative would be to just decontaminate those specific parts of the reactor coolant system where access is required.

(Question) - What are the calculations of what the reactor vessel activation exposures would be right now?

(Answer) - If the uranium dioxide sand got out of the vessel and into the primary system, the most difficult problem at present might be contamination of the heat exchangers. But in the long term it might be the debris that is settled in areas and

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then gets dislodged during operation. This can lead to bursts of activity. It is a rather insidious problem that the hot spots today may not be the major contributors of the problem of tomorrow. There is another thing that I would like to point out. Just because we have concentrated chemical solutions does not necessarily mean that they are unduly corrosive. I've seen corrosion data that show that a dilute process can be far worse than a concentrated process for corrosion. Also it's a matter of time and temperature.

(Question) - Have you considered the possibility of some mechanical type cleaning processes as opposed to chemicals for areas that are accessible, such as the vessel?

(Answer) - We considered it, but not very strongly. We have done some work in steam generator cleanup, and some of the things you are describing and the quality of DF's that you are considering are obtainable. I could see, for example, mechanical cleaning of the inside of the vessel if you could pump it out with materials that wouldn't be incompatible with the reactor. Considering the kind of contamination that you have, it's conceivable that you could get some pretty good cleaning. I guess we would like to find a simple, inexpensive, fast process that would remove all contamination from the areas, particularly in the vessel. What we need are artifacts. Right now we are trying to guess. We are going to have to work on the schedule so that we can get enough information to make these choices. You may come up with some way we can clean out the pipe. I thought of mechanical methods in the areas in which you may have to do refurbishing such as the primary system.

(Question) - Did you use any kind of acid reprocessing or just dispose of the solution completely?

(Answer) - Well, our conditions are so much different from the usual ones that I don't think it would be very fruitful to go into it. We were on a government reservation that has its own special ways of handling waste. The Navy at Shippingport used ion exchange to take care of the solutions that they used in the system, and they generated an enormous volume of waste. You may be able to concentrate that waste by having a tank with the acid solution in which you introduce the AP into it and it generates then an MMO2 block that will carry most of the activity to the bottom. You should be cautioned that you can generate a very sizable amount of ammonia gas. Most of these chemicals do have ammonia in the compound. It seems to me

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that if you can totally drain the reactor vessel and the primary loop, it would be worth looking at some more conventional methods of cleaning like we saw yesterday on cleaning hot cells. You could rig up to remotely travel the walls of the vessel which would reduce volumes. But that's only a part of the system. You could look at the same things that you use to clean the piping systems. Perhaps high pressure jets could be dragged through the system. They could also produce less volume. I could throw out two or three real exotic ideas for reducing volume that are certainly not developed. You could use foam cleaning although the development of that technology is almost non-existent. Foam cleaning of external surfaces is commonplace, but I was referring to the carrying of decontamination agents in foams to clean up large vessels or piping systems. You can reduce the volume of the foam by about a factor of 20, but still carry a very concentrated chemical solution. There's a fairly well developed technology in non-condensed phase cleaning and foam cleaning in the chemical cleaning industry, especially for removing the usual corrosion deposits. But to my knowledge there is very little technology that's gone beyond the laboratory stage as far as decontamination is concerned. That doesn't mean that you can't get some usual information pretty quick. I've done some work 10 to 15 years ago, but running one or two experiments and seeing that it works is certainly not development of the technology. The process for decontamination of a reactor has to go through a lot of very well defined steps, and I think we have forgotten some of these in the last few years. You do something in the laboratory, then you go to the bench scale flow system, then to a little bit bigger loop system, then you go to an end reactor loop to check it out, and then you go full reactor. If you bypass any of those steps you are in serious jeopardy of any one of these nasty surprises about redeposition or something like that popping up. It's a pretty well worked sequence. It's the kind of exotic thing that I was mentioning that has only gone through the laboratory and the first bench scale test. They can cut the volume down of the waste by maybe a factor of 20. There's another way you can look at that screening too. It's okay to say it has to be compatible with your system, but if there's no adequate method that is compatible, you have to see if there is any way I can handle this waste from a useful decontamination process. There are no radwaste treatment systems around today that can handle decontamination waste except at Dresden. It doesn't mean that they can't be adapted, it's just a matter of design and a combination of chemistry and conditions. The current technology now applied in existing systems is not sufficient to handle waste from decontamination processes. Even if you are talking about CANDECON you have to install added ion exchange capacity to take care of the problem. Now the

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Epicore 2 system is designed for medium level waste. It has a flow rate of 10 GPM. This is a very slow process. The system is limited to a 400 R/hr reading. This waste is in the auxiliary building. The high level waste is the sump water and the reactor coolant. Both areas have about the same relative amount of activity.

The strontium is higher in the reactor coolant than it is in the sump water, but the cesium in the sump water is higher than the cesium in the reactor coolant by about the same ratio. The reason being, there was delayed release of strontium into the reactor coolant during the accident.

One of the things you might want to ask is, "Who is really up-to-date on ion exchange? What might one want to do to change the specific stream placed in the mixed bed?" Cesium is difficult to extract. The type of resin that you have in normal operation might be different from the most ideal ones for stripping out large amounts of cesium. I would not say design one system for processing sump water and another system for treating reactor coolant. It would be my guess that one system could do both jobs.

(Question) - What plans have been made to reuse water that's been cleaned up during the decontamination effort? I mean, you are going to be generating a lot of water and you are going to need a lot. You may have problems dumping this water to the river or getting rid of it any other way. Is there any planning to reuse this cleaned up water? You can probably take water that's not dumpable to the river and reuse it for the decontamination effort.

(Answer) - One of the reasons for putting in these storage tanks is because we can't dump any water. It's not that the water doesn't meet criteria, it's just that nobody will let us dump it. So we are installing the tanks to store it, reuse in makeup to the reactor plant, and for decontamination. They have been kicking around all kinds of things to do with the water. Future cleanup is one of the purposes that is planned for the water.

(Question) - The problem with the water as I understand is the build-up of tritium.

(Answer) - Yes, but that can be diluted prior to dumping. It's really not a big problem as far as dumping into the river. The legal and political problems are what

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we are faced with as far as getting rid of the water. Since the political problems seem to be the largest hurdle, the next best method is to use the water for future cleanup. A lot of thought needs to be given to moving the water out of the RCS.

(Question) - Will the chemical composition of the sump water interfere with the cleanup by ion exchange methods or not?

(Answer) - The present water in the containment sump and all the water in all three levels is really very good water. Some of the people here may have been at the Sun Valley Decommissioning Conference earlier in the year. I think one of the things that was pointed out there, and it may have some applicability here is: soon after their license is received an individual should be assigned at a plant who is responsible for the plans and decommissioning of the plant(s). Three years is not a long lead time for decontamination. Just ask the people at Commonwealth Edison what they thought was necessary lead time for decontamination. Four years ago they would have said two years. There are problems that crop up as you go along and it's necessary to tackle them early because you will have the institutional inertia in Washington to deal with, particularly in the areas of significant public health and safety impact. Therefore, I couldn't impress more on you the fact that you need to take advantage of all the lead time you've got as far as decontamination is concerned.

HIGH BETA FIELD DOSIMETRY WORKSHOP

DISCUSSION LEADER - ED WALKER (BECHTEL)

HIGH BETA FIELD DOSIMETRY WORKSHOP

Discussion Leader - Ed Walker (Bechtel)

My name is Ed Walker and this is the High Beta Field Dosimetry Workshop.

We have some problems at Three Mile Island in terms of beta dosimetry. Hopefully, people in the room will have either solved this kind of problem already or maybe have ideas on how we can solve them, and to see if we can come up with some ideas and applications. Penetration R 626 is a hole that is 11 feet over the operating deck of the containment. Some of the problems that we have are associated with measurements that we want to do there. We have extremely high humidity, somewhere in the range of 100%, and a large noble gas cloud which may or may not affect certain types of instrumentation that we want to stick in there. Another problem is what kind of beta dosimeters do we use with the initial re-entry team? This is scheduled as was previously mentioned, sometime in the later part of January, 1980. We're looking at two different things, if you will, the personnel dosimeters for beta measurement and portable instruments for beta dose rate maps inside the dome. What I'm looking for here is what is available to us today in terms of what we can use directly or what we can modify. This might involve some developmental ideas. I think we've got time that if we had to come up with new instruments or something that hasn't been designed or isn't available today, that we can develop something to satisfy this need.

I plan to run this session fairly informally and I think one of the things that might be beneficial is that if people have ideas or thoughts or if you want to draw up sketches or anything like that, please feel free to do so. The primary objective is, what can we use to satisfy these problems? Maybe we can start off with the first one: We've got that hole up there -- what would be the best instrument to stick in there and measure the beta dose rates (keeping in mind that we have two components: noble gas and beta deposition on the surfaces)?

The plan is to use what we're calling a "TLD tree." The idea is to put TLD's in pairs -- at least in pairs -- and the primary objective judge of this exercise is to measure protection for the clothing that we want to use in the initial re-entry team. One of these TLD's would be shielded by beta guard (prospective clothing material) and the other TLD would be essentially bare. This will give us a measure of the beta dose reduction expected from the clothing.

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(Discussion Leader) - Highly contaminated areas may have high beta fields and also present difficulty in characterizing these fields. Precise dose measurement, such as done by an extrapolation chamber, may not be feasible. Fortunately, approximate energy spectral information can be obtained from simple absorption measurements. Our group has suggested the TLD holder for use in contaminated hot cells. Ten sets of three TLD's each are symmetrically placed in recesses around the periphery to minimize differential scattering effects. One TLD set is covered only by the thin mylar retainer sheet while the others are covered with increasing thicknesses of aluminum foils. Although the usual TLD is not thick enough to stop all betas, the holder will give an approximate absorption curve. These devices are simple and inexpensive, thus several can be placed in a proposed work area either remotely or with a minimum of personnel exposure. A thin plastic bag should be used to avoid contamination. The resulting absorption curve can be used to select a suitable beta calibration source or factor thus allowing reasonably accurate beta dose assignments.

The machinist can throw the tree together in no time at all because it is all symmetrical. Otherwise, your geometry confuses the data that you get from the betas and gammas being mixed.

(Question) - Do you know what specific chip data we are using?

(Answer) - I understand that it is somewhere in the neighborhood of 235-250 milligrams, then I'm not sure what their Teflon is. I would guess it is 19 or so milligrams per square centimeter.

(Question) - Are these chips available from Harshaw?

(Answer) - Harshaw has the chips. I don't think they are made of Teflon material. I thought you meant Teflon covering that was across. It was a bare chip with Teflon covering across it.

(Comment) - No, that is teleadon isotopes.

(Discussion Leader) - The problem is that they are a special order item. Also we do not have on-site readers for these either.

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I think that we are going to have to recognize that what dosimetry we currently have on the site is probably anywhere from marginal to not adequate at all for what it is that we're going to do here. We have already identified some months ago that it was not adequate for the spectrum that we see in containment. I think that is a well known fact. I don't think there is any problem there as long as we realize that the 235 milligram per square centimeter filter across what we call the non-penetrating dosimeter does not in fact filter out all the betas. Therefore we do not have a penetrating vs. non-penetrating dosimeter as far as the primary coolant is concerned. Another big problem that we have is that the spectrum was changing fairly rapidly; we see significant changes month after month. The Sr-89 has been changing for the last couple of months and the spectrum is hardening. As the spectrum hardens, the necessity for the filters changes as far as the density of the filters. Right now we have a spectrum that where 450 to 500 milligrams per square centimeter is enough to filter out effectively all the betas. This is not going to be true two months from now. Another one of our problems is the fact that we don't have a static condition. It is changing with time.

That particular problem is addressed in the second item that I have here and that was the personnel dosimeters themselves that we want to use on the first entry team and further on down the line. I think also you want to be careful concerning your isotopic concentration. The spectrum is going to be affected by many things. You are going to have partial filtration, geometry effects, scattering, and air paths. To take theoretical spectra based on what you think at that particular time is not really the way to do it; you'd better get a little more information. I would like to have a beta spectrometer in there, but this is all we can do right now. We have a "poor man's" beta spectrometer and it is simple. It is something you put together in a day or two. I suggest it is not a beta spectrometer, it is a radiation spectrometer. There is a lot of garbage in there. I wanted to point out that this will give you some kind of regional spectrum. Don't try to calculate dosage from this, you will be in trouble. The whole object of this exercise is to get somebody in the containment and have some idea how we can protect that individual and how we can determine what kind of dose he gets once he is in.

What we currently have available to us doesn't even appear to be adequate to give us the data.

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(Comment) - One comment on the TLD tree: It strikes me that the beta spectrum is a function of the distance you are from the wall (that vertical wall) so if you push your tree well in, then perhaps the bottom of the dosimeter will reflect the harder spectrum of the deposition on the vertical or horizontal surface. The top spectrum or the top TLD system will reflect a difference. But if you are too close to the wall, all of them will be roughly the same.

(Discussion Leader) - Well, there is still some question on that too because we don't think the concentration on the wall is anywhere near the same order of magnitude as the concentration on the floor. You are probably talking about microcuries per square cm of deposited activity, and you are probably at least an order of magnitude higher on horizontal surfaces than you are on vertical surfaces. So it is something that we have to think about. The range of the beta particles in air are of the order of a meter or two, so the TLD at the head level, the 6 foot TLD, will reflect pretty much the gas cloud unless it is close to the wall. Then it will be overpowered by the surface radiation. We would say that the beta dosage from the cloud in here is in the hundreds of rads per hour whereas the beta dose off the surface is more likely in the rads per hour reading. I'm not talking to you about dose, I'm talking about energies spectrum. When you finally get this thing out of here, it is affected by both. You know a TLD is going to respond to both, so what were you really seeing? These are factors that we have to consider when we actually do this measurement.

(Comment) - I think Don Jones was talking about a system that has nearly 4 response TLD's on both sides of the plaque.

(Discussion Leader) - I think it sounds like we can still do a major survey with this TLD approach.

Are there any other thoughts then since I know one of the things that we were looking at was the possibility of something like a gas proportional tube?

(Question) - What measurements have you taken so far, in this range?

(Answer) - Earlier on we put in a board that had two detectors on it. One was, quote, gamma chamber, the other was a beta chamber. I don't think either of them

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appear to be sensitive to Krypton in-leakage. The beta was a parallel plate ionization chamber and it was fabricated out of aluminum frame. It was probably about 1-1/2" square and had about a 1" diameter window on each side that was probably 1/4" thick. The thing was then held together with machine screws. It didn't look like they were gas tight. The gamma probe looked like an air wall ionization chamber and it also had an effective wall thickness in the neighborhood of about 150 milligrams per square centimeter. Even if it had been gas tight it is still going to respond to Krypton beta spectra. So we didn't get a representative gamma reading of it at all. We have since used a teletector and there is 700 mR/hr.

(Question) - Were you on the beta probe, beta-gamma probe or the gamma probe with the teletector?

(Answer) - Beta gamma. However, the teletector has two probes in the end.

(Question) - Has that been adequately calibrated for beta?

(Answer) - The teletector, so we understand, has been calibrated. Incidentally, this 700 mR/hr measured in the range of what we would expect it to be, based on our knowledge of the Krypton concentration in there and our predictions on deposition activity on the floors. If you combine those two gamma sources from the predictions, they come up in the range of this 700 mR/hr.

(Question) - Have you put any TLD's in?

(Answer) - No, we have not put any TLD's in yet.

(Comment) - You might want to do something at first, and that is to expose TLD's on a straight shot through without trying to hang them down on this tree and worry about where you are located with respect to some index. In effect, put the TLD right where the teletector head was and get some rough idea of what is going on.

(Discussion Leader) - I think that we have pretty well agreed that the TLD-type system that we should be using is something along the lines of this. It should discriminate between beta or gamma. First you should put a shield in front of a chip

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so that you can be sure of gamma exposure. We are going to try to test the protective suit material that we want to use.

(Question) - Will the suit be perfectly gas tight?

(Answer) - It will have a positive pressure. At Nuclear 1 we have had a similar problem. It wasn't Krypton but Xenon contamination. We took our TLD's, Harshaw 700 series, and we outfitted a man with a TLD outside the Anti C's, a TLD inside the Anti C's and another TLD outside, but sealed in plastic envelope. The difference between the TLD exposed to the Xenon atmosphere and the TLD in the plastic outside the envelope was the difference of about 34 mR beta for a 1/2 hour period, in a 60 to 100 mR/hr field.

(Question) - So you only had a factor of 3 protection with your protective clothing?

(Answer) - Yes.

(Question) - Is this for beta only or beta-gamma?

(Answer) - It was for beta. It was the beta chip that we were interested in. What we were interested in was to see how the Xenon affected both chips due to the Xenon being trapped in the TLD holder itself. But, of course, the major contributor from Xenon 133 is the gamma dose, and we are talking about 20 beta to 1 gamma for Krypton 85. So I think we have a much different environment here.

In this particular case, we determined that the dose to the meter was 35% greater than what the person really got because of the Krypton inside the meter.

(Question) - Do you have any suggestions on how to avoid this?

(Answer) - Yes, put it in a plastic bag.

(Question) - Did you find that the plastic bags kept the Krypton out?

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(Answer) - Yes, for a reasonable time.

(Comment) - The reason I'm asking is that we ran some experiments with some of the modern installed radiation monitoring systems; the standard ones that you put into a power plant for particulate ion and gas use in calibrating Krypton 85. We noticed the phenomenon that we used high levels of Krypton 85 for maybe five minutes, then flushed the system with fresh air so that we were fairly sure that we were rid of everything. We noticed that the Krypton 85 diffused through the mylar barrier in front of the beta windows and stayed there. We had backgrounds that normally should be 50 counts per minute that were 10 or 20 thousand counts per minute for half a day, and that is only with a five-minute exposure. Therefore, we obviously had rapid Krypton 85 diffusion through the standard mylar barrier that the standard radiation monitoring system utilizes. It taught me that the beta phosphor design for measurement of the Krypton was sort of useless for our levels of Krypton. There had to be a new design. The problem is that it is about the only thing available now. There is significant diffusion, about 20% of our highest level.

(Question) - Did you do anything with polyethylene instead of mylar?

(Answer) - No, we only used what was commercially available at the time. In fact, this system was done for Salem. It was done for Norm Millis' group.

(Comment) - Some of that may not necessarily be diffusion, it might be in the absorption on the plastic. You may find a significant difference from one plastic to another. Our people who made some of the entries into the cell areas found that they had quite a bit of difficulty getting the technicians to make accurate readings off of the meters, because of the plastic bag and the poor lighting and the reflection. So you want to test that very carefully under similar light conditions.

(Question) - Will the entry teams have the ability to see the meters?

(Answer) - That is one of the things that will be tested. We plan to do dry runs in Unit 1. A lot of these things that we have questions on, hopefully will get answered during that kind of dry run. That will be done with a darkened containment where the

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only light available to the people will be the same lighting that is going to be available during the entry into Unit 2.

(Question) - How long will the first entry take?

(Answer) - That still hasn't been fully determined. We are looking at probably 15 minutes. My personal feeling is that this will probably be on the first floor only. The primary objective of the first entry is to get the door open and put somebody in and start taking measurements. There is more of a psychological barrier right now than a technical barrier. We want to get in the containment and start the clean-up. There are several problems with making an extended tour, such as going up to the 347 level. The biggest problem is that we have a 40-foot climb through an open stairwell. That area probably has sump water in the bottom of it. That is going to be one of your high dose rate areas. The guys are going to be loaded down with an extra 80 pounds of weight. A forty-foot climb with just your street clothes on can be kind of tough sometimes, especially if you are trying to do it in a hurry. There is still a question as to how far we plan to go, but I would say it probably would be limited to the first floor. The total travel path is in the range of 100 to 150 feet. The containment is about 75 feet in diameter. One of the things that we want to do is test the clothing material. I think that the physical arrangement between this clothing material and our detector system is also important. It almost sounds like unless we can surround our detector with the clothing material, the protection factor may become meaningless with this kind of detector system.

(Question) - Have you determined the absorber thickness of your clothing?

(Answer) - Our original intention was to actually take the materials that we plan to make the suits out of and test them. The materials are all along the rubberized material concept; this would include things like wet suits. We've got material right now that we consider the leading candidate, it's called beta guard. We still don't know a whole lot about it. We will run the test to determine the protection factor for this beta-guard material. The beta-guard material is a neoprene-type material. We have done a series of tests with the RCS plaque and have run some tests using that material.

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It indicated a beta attenuation of approximately 92%. The second test that we ran indicated somewhere between 80 and 90%. The thickness is 307 milligrams per square inch. A prototype suit is being made with two layers of this material bonded together. Unfortunately, because the material is so thick, it is going to have to be fairly close to the measurements of the person who is going to wear it.

You've a serious problem in that kind of a suit with regard to ventilation; you can overheat very quickly. This material has and is being used as aprons as a beta protector material. I'm having a prototype made for testing.

In tests to date, I only got between 72 to 75% reduction. It didn't afford quite as much protection as hoped for. For that material we have a two prong testing approach; one on the survivability of a man, the other one to determine what kind of a real protection factor is involved.

Shielded boots will be used for floor contamination protection. One of the tasks that I would like to see done is to take swipes off the floor. That's where we test out this suit.

(Question) - What are your sampling plans for these measurements for the wipes?

(Answer) - I think that will control largely what kind of protection you want to provide the man. Again that hasn't been very well developed. What I have in mind is to start off with standard wipes.

(Comment) - I don't see why you have to do that. If you are worried about protection, you could use a specially designed boot with a piece of wipe material in it, and he could wipe wherever he walks.

(Discussion Leader) - Don't forget a very real thing. These guys aren't going to be walking around in a room that is open. They are going to be walking up close to vertical surfaces. Indications are that the vertical surfaces have a lot of cesium and ruthenium on them. We're talking about a 3 to 3-1/2 MeV beta. We found that the beta field from the floors is pretty uniform at waist level. We are not talking about just a foot problem, we are talking about a problem that is fairly

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uniform up to 4 or 5 feet off the floor. Then there are going to be isolated problems on the floor that are really going to be hot. So, who knows what we are going to find in there. It is not going to be just a swipe on the floor problem. There is likely to be a problem everywhere.

(Question) - But if bending over and then getting down close to the floor is a problem, why require the man to bend over?

(Answer) - He is going to be reaching out and doing this kind of thing too, so a guy doesn't have to bend over. The current plan is not to have the man bend over. He will have a long tube with an absorbent material in the tube that you would extend, take a swipe, and pull it back in its tube and not have to bend over when they go in the building. The building will more than likely be under negative pressure and we need to test these suits in the Unit 1 experiments. The behavior of the beta-guard suit in Unit 1 could be slightly different in Unit 2.

(Question) - Have you decided how far from the entry that these people are going to wander? You said they were going to stay on one level probably, do you know how far you want them to go?

(Answer) - Not exactly. What we are going to do is look at where the hot spots are and where the things are that we obviously want to get to. For example, if there is a real hot spot in an area on the first floor, if it is of low interest, obviously we won't send them in that direction.

(Question) - You may want to consider having the first entry with an air-supplied suit because of the problems.

(Answer) - A man is going to have a 25-pound suit on, which is more than two wet suits. I have worn two wet suits and it is really hard to just walk around. Then on top of that you are going to have air-breathing apparatus. It might be better to consider having a 100 or 200 foot air supply line and not having 40 pounds of bottles on the back of the man of the initial entry. I've had many a guy pass out on me in just plain old 2 suits of protective clothing over the years and if this guy is going to have all this on, I begin to worry about him.

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(Comment) - The problem of air supply right now is the airlock we have to maintain.

(Discussion Leader) - That still has not been completely ruled out. We have thought about attaching an air conditioning unit up similar to that used by NASA. Another suggestion is to leave the meter outside some way. That is one of the other things that we are planning, a digital readout system. Right now we are planning telemetry to the outside. We will have all three belts instrumented and we will be constantly reading out the dose that they are getting on this digital system.

(Question) - Does anyone here have any experience with the German gas amplification ion chamber called the Toll E? I noticed that the Government of Germany has now officially adopted it as their official survey meter — it goes to 30,000 R/hr and easily reads out a few mR/hr. You can use it with gas amplification and without. It looks like the Mercedes of instruments and I was wondering if anyone actually had hands-on experience with it. On paper it looks beautiful.

(Question) - What does it measure?

(Answer) - Well, it is an ion chamber and there is a tissue equivalent plastic that comes with it. It measures dose to tissue so to speak. It has a pretty thin window, around 10 milligrams per square centimeter. Therefore, if you keep it capped, it would measure tissue equivalency; if you open it up, then it is going to measure some percentage of betas.

(Question) - I am a little curious about your respiratory protection with this environmental backpack. We just purchased 8 of them and have used them in the reactor compartment at 100% power. The humidity that you breathe in stays within the system. In a very short period of time you get more or less a raining effect inside the mask. I used one for a half hour. It got to the point where it was difficult to see through the mask. You do have a by-pass but it does not seem to clear up the mask like an SEBA would. Other than that I think the machine is beautiful.

(Answer) - We just got rid of all of our environmental packs. We had problems with CO₂.

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(Question) - How sure are you as to what the characteristics of the atmosphere in the containment building are?

(Answer) - All of the air samples indicate an oxygen deficient environment. I don't think we have enough data that we can say exactly what the condition is, but the range of data indicates anywhere from 12% to 17% oxygen. That in itself is a problem in selecting respiratory protection.

(Comment) - My thought was that with the radiation fields that you have had in there, you might have some strange chemicals due to ozone reactions.

(Discussion Leader) - Yes, that is something that we haven't really solved. We are testing our gas samples. It has already been recommended by other people that we should start looking for things like methane. For example, do we have any decomposition of electrical insulation? If we do, that can produce toxic fumes. To date, I don't think anything has been done to determine if this problem exists.

(Comment) - You need to be very cautious about the air supply for the people that are going into containment; CO₂ may be the least of the problems you encounter.

(Discussion Leader) - That is one of the strong factors that dictates our criteria in selecting a respiratory system; we are assuming that there is a toxic atmosphere in containment right now. You have the ability to breathe for at least about two minutes with the oxygen attached. If you do release your oxygen supply, it becomes a little difficult to breathe, but you can still turn around and walk out, whereas in the SEBA, if you have lost your air, that is it. You have to worry about your mask or suffocate. You know for a fact that if you lose the positive pressure, from the O₂ bottle it becomes very difficult to breathe.

(Comment) - The danger of a re-breather is the very subtle change of the atmosphere as you are breathing. If you enter any closed circulation system, before you even realize it, you will be out.

(Discussion Leader) - Your oxygen supply, that little 6-1/2 liter oxygen bottle, actually supplies the positive pressure in the mask. It is somewhat easier to breathe.

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If you should happen to lose that, it is quite noticeable. We tried to make as many extensive tests as we could with it. We were somewhat unsure of using a re-breather. It has an alarm system, a whistle. This warns of the loss of positive pressure. The difficulty in breathing is when you lose the positive pressure supplied by the oxygen bottle. Unlike the old style canister-type re-breathers, you will notice the loss of the oxygen supply through both an audible alarm and the difficulties in breathing. There are several symptoms that I think a trained technician would be able to observe if he did lose his oxygen supply.

(Question) - How long did it take for that fellow to pass out?

(Answer) - We had some go down in 20 seconds' time!

(Question) - Did they have any idea they would do it ahead of time?

(Answer) - No. His system was a demand system. The new systems are positive pressure system. You have the positive pressure just like the SEBA. The question is, do you go with an open-circuit system and have to rip off your mask, not knowing what your atmosphere is, or go with a closed-circuit system and take the chance that, when you pass out, somebody can carry you out while you still have respiratory protection?

We need to have some assurance that we can relate the gamma dose that is coming off the telemetry dosimetry on the entrant to the actual dose (beta and gamma) the man is receiving. There must be a confidence factor. A gas proportional tube with a thin window may suffice. I don't have any personal experience with this kind of a system in this kind of an environment, so I was wondering if anybody has any constructive ideas on that. All that we are really doing with this thing is getting a beta map at the location that we plan to put these TLD's.

(Question) - Why wouldn't you want to take some portable instrumentation that you are planning to use in the mapping and put it in the 9" diameter containment opening and see how it behaves in that environment?

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(Answer) - We could do that. I would like to use an instrument that could give a directional measure of levels and spectrum. We could run out over the reactor if we had a boom structure to do it. The original beta-gamma map that was attempted was done from a distance of 10 feet from the wall and then, down to the floor.

(Comment) - I think it would be nice to actually use a beta spectrometer in there and take a look at what your spectrum is and how it changes with direction and with distance away from the wall.

(Discussion Leader) - I think the first thing that we need to do is to simply get a good beta measurement; then we can get more sophisticated.

It would be easy to put a couple of silicone diodes in there which can be obtained with a pretty thin window, and get some idea of the spectrum. You could put two identical ones in, one with a shield and one without.

There is 0.8 microcurie per cc of Krypton, almost an infinite cloud. It is roughly about 200 R/hr beta based on theoretical calculations. One of the things we got when we stuck in that original parallel plate ionization chamber was a reading of 390 R/hr throughout the entire map. This leads us to believe that gas leaked into the chamber because when they pulled it back into the glove box, it was still reading 390 and they thought that was due to containment gas that got back in the box. When they pulled it out, the dose rate went away and they assumed at the time that it was because the Krypton was in the box rather than the chamber. Whether you are talking about passive detectors or active detectors, you can really get a lot of information if you use the multiple filter technique. For example, you can normally make the same filter thicknesses out of higher Z material and lower Z material. You can really do quite a lot with small detectors whether it is passive, TLD's or active silicone diode or ion chamber or whatever. The beauty of a little passive system is that it is simple to build such a thing. Good gamma shielding can be obtained through the use of machineable tungsten. You can do the same thing with a silicone diode or an ion chamber.

(Question) - Is there any chance of getting a simple manipulator through that hole?

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(Answer) - We thought about that in the past. I think the answer is yes. It will require a little bit of imagination because I don't know of anything that we have right now, or that is available off the shelf. We need some sort of articulated arm that could take a swipe off the floor or the wall. We attempted to get a swipe off the floor with a simple device that was dropped down and the last that I heard, it was hung up. I think they are ready to cut it and let it fall back in. One of the things that we included that was good was some sort of swipe material on the bottom of the arm. It is such an easy shot getting in and out of this hole, I would think that a simple mechanical device could be used to determine what is stuck to the walls and the floor.

(Question) - Is that hole being used for anything else?

(Answer) - No, it is strictly an experimental hole.

(Question) - What do you have to do in order to put a detector tree in? Do you have to write a procedure?

(Answer) - Yes, you must write a procedure and fabricate the equipment. The procedure is the big thing.

A concern we had mentioned earlier is the ozone environment. If the equipment has not been perfectly watertight or atmospheric tight, the ozone could probably attack the solder joints, especially the silver solder.

(Comment) - It sure sounds like you want to make a real effort to have a clean atmosphere in there before you send the men in. I think you are making a big mistake by talking about sending the men in without cleaning out the Xenon and whatever other contaminants are in there.

(Comment) - Let's go back to your idea of a proportional counter being dropped down in there. I don't see anything wrong with that at all except for the obstructions that are in the way.

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(Question) - Has anyone asked the question about high range beta survey meters, above 500 R/hr?

(Answer) - No, we haven't gotten to that topic yet.

(Discussion Leader) - The configuration TLD that we talked about using on the penetration sounds like a type of system that would be applicable for the personnel that are going to make this first entry with noble gas. We might be able to utilize existing portable instrumentation if it is wrapped in plastic to the extent that it keeps Krypton out. Is there anything more that could be added in the personal dosimetry systems or personnel monitoring systems to go in with this initial re-entry?

(Comment) - One of the things that you might consider: Using the phantom dressed in the proposed clothing with the proposed dosimeters on it. Shove it into the containment and make some measurements before you put people in.

(Discussion Leader) - Yes. You're getting some chuckles from some of the people who work on the island because we called that the mini-entry. It has been shelved. The inner door on the airlock is open and will be for the re-entry team to go into the building. However, we haven't forgotten the phantom, because it may still turn out that it is absolutely necessary to do what you are talking about. We have another penetration here. There is a possibility of using one which is down on that 305 level in the area of the personnel airlock.

(Comment) - All I'm suggesting is that all the usual caution, plus a little bit more, ought to be used in this program. I'm proposing that you guys be conservative in whatever you do and do it very carefully because I can see making mistakes in this process that will wind up to harm you rather significantly. Caution is the word.

(Question) - How about the use of robot-type machinery? Any thoughts on that?

(Answer) - It was thought of, but there is a bad taste in everybody's mouth from the robot that was used here originally. What it was designed for and what we tried to use it for were two different things.

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(Question) - It seems like a mechanical being would be useful.

(Answer) - We have looked at a lot of robots from DOE and we have also talked to a lot of people at Los Alamos. Back in June, when the task group got together, we had a whole series of robots parade for us. The trouble is that the personnel air lock was difficult to negotiate. You go up and down, on Caterpillar track type tractor treads; they just could not negotiate it.

The other problem was that most of the required cables were not remote powered. We also had trouble at the time rigging up something for communications to control them because you are going through four feet of concrete, and we didn't have the penetrations yet for radio control.

(Question) - So what you have got now -- do you think it is any more feasible?

(Answer) - From the robots we have seen, I don't think that we will use them, given the Krypton purge.

Getting a guy in there is probably easier than getting the robot in there.

(Comment) - Put the man in the robot.

(Discussion Leader) - That is a good point, a man and a robot. We haven't ruled that idea out either. As far as robots are concerned, I don't think there is anybody associated with the problems we have that feels that we have anywhere near the conditions that justify that.

(Comment) - Yes, I would think about robots if we were talking about 1,000 R/hr. We don't even have, for the most part, hundreds of R/hr.

(Comment) - I think that if you are not going to purge, you have got a relatively hostile environment there, both from a breathing standpoint and from a radiation standpoint, and that you don't know enough about at the present time. Not knowing enough about it leads me to be a lot more cautious.

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(Discussion Leader) - If it turns out we cannot purge, and it also turns out that with that we don't put people in the existing environment, our next approach on data gathering would be to go through every spare penetration and gather data remotely.

(Question) - Why aren't you using some sort of pin-hole cameras to look for hot spots?

(Answer) - No reason.

(Question) - Right now you don't know where the hot spots are, you are guessing.

(Answer) - We have done a jelly-detector scan of the 305 entry level through that equipment hatch and that's better than a pin-hole camera right now in my estimation.

(Question) - Do you have maps that tell you what the hot spots really are?

(Answer) - We have maps of different angles. We do know the general levels. That is how we inferred the plate out in those areas. One theoretical hot spot that has got us worried is the containment air coolers. When we went in with that jelly detector, it was lined up parallel to the floor. The air cooler banks are up about 20 feet in the air. Our estimated doses, if you look at an internal recirculation filter, say that those air cooler fans (which have been continuously running) could be at 200 R/hr. The only other hot spot that we have identified in either two studies on the 305 level is the concrete masonry blocks at the stairwell. Because they are porous and absorb, we calculate some rather hefty dose rates from that area. Then there is the equipment hatch block out area, where you move equipment. That could be looking down on top of the 120 R/hr field where the sump water is. I can't see that 120 R/hr field that is over where the equipment hatch is because it is out of the range of the jelly detector scan position from the equipment hatch. But what we are planning to do is to go in the personnel airlock, have the inner door still sealed, and use the jelly detector. We will scan over towards that area where the concrete masonry blocks are and also where the open area in the floor is, that overlooks that sump water. We will see if those are imagined potential hot spots or not.

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(Question) - What sort of directionality did you get from the jelly detector?

(Answer) - Very good -- that is how we located the water. We have a columnator set up. We have it down to a pencil-like beam.

(Question) - What kind of directional instruments are you planning on the re-entry team having?

(Answer) - Right now we don't have any directional instruments planned but we are hoping to have suggestions on what instruments would be beneficial for the re-entry team to take in. One of the things that you must remember is that we must consider the weight of all equipment. These guys are already pretty well loaded down with protection equipment, breathing systems, and instruments.

(Question) - Have you thought about taking the fish twine and taking it over and bringing something back so that after you are out of the range you have a cable across that you can carry things on? It would then be there to help get more data after the team is out.

(Answer) - The only place you can do that is above the reactor, and about the only way you could do that would probably be like "Mission Impossible," shoot something from that penetration.

(Comment) - No, he is talking about the re-entry team, setting up the fishline and pulling the cable in later. They don't have to carry the cable.

(Discussion Leader) - I am not sure that we can really get into containment from a health physics standpoint with the building not vented. It is just that we don't know enough about going in with that kind of Krypton 85 field.

(Question) - Has someone done a dose comparison, venting vs. non-venting?

(Answer) - The environmental statement and the request for doing so have been submitted to the NRC and the environmental impact statement discusses the dose to the nearest person offsite. This can be compared to in-containment dose.

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We have one study that says we can send people in there if we get a factor of 1,000 protection per beta; we don't know whether we can do that yet. We are going to live within the quarterly exposure limits, so we are limited there as to what our exposure can be.

The hard fact is how to get 1,000 protection factor against the betas. The mechanics are known. If you have any individuals that are picking up significant exposure at all (working in the building) that is going to be a much greater risk than the environment. The 50,000 curies of Krypton 85 is less than a BWR puts out under normal operations.

(Question) - Are there any other problems except permission with venting?

(Answer) - No, just administrative.

(Discussion Leader) - I would like to ask a question. Has anyone had any experience with the Z-Tex Tolemetry Dosimetry?

(Comment) - Yes, it has been used at Quad Cities on two or three outages. When it first came out, they were having a real hard time getting any kind of reading through that much concrete. Problems occurred in going from one point in the reactor building, just through the columns. So we went back and put in one or two jacks and I believe it is better. I'm going to talk to the people myself and then get back to you people and let you know what is happening. I know they used it during their last outage.

(Question) - Was their base station outside the reactor?

(Answer) - Yes, it was at the control point outside the job.

(Question) - Were they using an antenna inside with the amplifier?

(Answer) - I don't know. I will have to find out.

(Question) - What type of fields were they using?

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(Answer) - 2 or 3 R/hr.

(Comment) - We should get the telephone numbers and the names of these people. It sounds like the existing type of personnel dosimetry that we currently envision is adequate. I am not talking about the badges that we currently use on the site, I'm talking about the discussions that we have had on TLD's. Is there something that anyone else wants to add to that?

(Comment) - Yes, why stay 15 minutes or one-half an hour for the initial entry? Why can't the initial entry be fairly short and you can guarantee the improvement and the protection ratio because you have unknowns there. Let's say you have a 2 minute entry at first and the guy comes back out and then you evaluate the field that he was in and then proceed? This business of rushing in and making a semi-permanent entry the first time through seems like a little bit of foolishness to me.

(Discussion Leader) - I am not sure that is just going to be a tradeoff. If you want to call it risk vs. benefit, that is exactly what it is. We are going to look at what we think the field is, what we are going to accomplish, how much time is that going to take, and how does that compare with the personnel dose. If it turns out that the conditions are going to be less than 1,000 mR, and that gives you 15 minutes of time, I fully would say -- use it.

(Comment) - I would endorse the alternative approach. I like the idea of not putting your whole dosimetry experience on a 15-minute package.

(Discussion Leader) - I'm not willing to say that is the way we are going to do it.

(Question) - Why not utilize a campaign of short entries interspersed by an evaluation of the information obtained?

(Answer) - That would result in periods of months between entries.

(Discussion Leader) - I think the only thing that will affect the dosimetry would be the noble gas cloud. That, at least in my mind, is the only significant variation that would impact on the kind of dosimetry we might want to consider. For example,

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let's assume that we are going in with a cloud in there. If we use plastic wrap, we could probably use the instruments we have today. Does somebody have an idea that there is something different we can do? The kind of instruments that we use right now would be something like the R02, which is an ionization chamber instrument from Eberline. There is a problem with the R02 in that it is a large chamber. It is like the old powder puff, the old cutie pie type chambers. Besides the size (which is a problem), the calibration needs to be different if you are going to measure surface doses vs. area doses. So we have a real problem there in how we are going to use a detector -- I don't like using a detector that large because of these two factors involved. I would rather use another detector because I don't think one can determine which calibration to use when walking around in an area. I don't like to have to put that kind of a load on the user of the detector. I am not comfortable with the use of the R02.

What we plan to do per a suggestion that was made by General Dynamics is to have the personnel read the scale and the position indication and don't do any dose interpretation. That is done by people on the outside in your control center.

(Comment) - What I am saying is that you need two survey meters. You need one that is going to measure the surfaces and you need another one that is for the areas.

(Question) - Why do you want to measure the surfaces? All you really want to know is what the person is getting.

(Answer) - The person is going to be close to surfaces as he walks along corridors, etc. This is one of the problems that I don't feel we have put enough thought into.

(Comment) - I don't know much about commercial instruments, but there are some that might be best. That would be something similar to the Victoreen cutie pie that has the styrofoam cup on the end of it, or a Panasonic 478. (You don't want a guy to drop it.) There is a new instrument built by All Physics Instruments in California that has two chambers with the second chamber surrounded by 1 centimeter or 1,000 milligrams per centimeter tissue or plastic. It has two digital illuminated read outs so you don't have to worry about light problems. You can also use an R03A which

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has a light built into it. Zetex also makes something called an Auto-Digimaster. These are one-chamber instruments so you either have to alternate the windows or you have to carry second instruments. This is necessary to get a penetrating radiation reading and a non-penetrating radiation reading.

(Question) - Would that be one of those instruments that plastic wrap will be required on?

(Answer) - Yes.

(Question) - When we are talking about plastic wrap, are we talking about hermetically sealed?

(Answer) - There is a question of what plastic to use. Plastics have different diffusion rates depending not only on the plastic material itself, but how they were mechanically handled in the process of manufacture. They go through different pressure rollers, and this changes the gas diffusion rates through the plastics.

(Question) - How was plastic compared to PVC? There is a difference in the manufacturing techniques.

(Answer) - Most of the plastic sheeting that is used is manufactured by a balloon technique where they blow a big bubble and slit it afterwards. Then the stuff is run through rollers and you actually have to test the material from a given manufacturer in order to know what the gas diffusion rates are through a given thickness of the material. There is no such thing as a standard number.

(Comment) - I don't think that we need to worry about this hermetically sealed business. If it is essentially gas type contamination, to the extent that we can seal with tape, it should be all right for a maximum of 15 minutes. As long as we keep the gas out that long, the thing to worry about would be diffusion or leakage. This would allow that gas to be essentially in there in the first 30 seconds after entering the building.

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(Question) - Could you test the material?

(Answer) - I think we could experiment. We could stick some of these instruments through that penetration and test with the different types of bags.

(Question) - Is there some reason why you can't take some of that stuff out of containment and use compressed gas somewhere else?

(Answer) - There is no reason why we couldn't. We would just need a system to do that, install it and get approval to operate. You don't have to compress the gas from the containment into a large metal container, you could do it in a plastic container or a plasticized bag and get enough volume to work with.

(Discussion Leader) - There are a couple of other things that we should look at on the instruments. Most of what we are talking about is airwall chamber, and we are worried about getting gas in the instrument, but you also have got temperature and moisture considerations. The R02 is only better because of the configuration of the case. It takes a little longer for the moisture to get into the R02 and into that -- the ion chamber. The ion chamber works on organic or ionized gas just as well as it does on radiation. If we start getting things in here like ozone, I think we are going to have to go to a detector that is sealed. I don't think we are going to be able to use the air wall ion chamber for a while. I think we are going to have to go to something like a proportional chamber or sealed or pressurized ion chambers. Your beta efficiency is down to a few percent compared to what we are seeing, on the R02, the cutie pie, or even the Panasonic, the coffee cup. The coffee cup is very bad about moisture too.

(Question) - Will a plastic bag help for about 10-15 minute duration?

(Answer) - That is really what we are looking for right now.

(Comment) - Well, there is one plastic that is better than others, as far as moisture is concerned, and that is Saran. Saran Wrap has a lower moisture penetration rate by a factor of 10 for a given thickness than normal polyethylene.

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(Comment) - What period of time are you worried about, 15 minutes or 15 weeks? What is the difference between plastics when you're talking about 15, 20 or 30 minutes? Unless you are worried about the chemical environment, you can test this by binding it up, placing it in a box and slipping it inside the containment. If you are concerned with moisture, I would check with the Canadians, because they work with tritium in their plastic suits. They can tell you precisely how long a given plastic will last before the tritium gets in. So, from a moisture content, it will probably see the same pathway. It sounds like nobody has come up with anything that we could look at that is new. We have to go with what is available today.

(Discussion Leader) - Our experiences have not been with Krypton 88. Our problems have been with Xenon. We did use an R02A in a plastic bag and observed for 10-15 minutes with no in-leakage. We used plastic bags, taped and folded over and taped again. It worked quite well. We did it on the initial entry when we went in. It lasted two minutes, then it quenched out on us. We had the Xenon in the chamber. The plastic bag serves its purpose quite well.

(Question) - How long did you say it lasted?

(Answer) - About 2 minutes. We walked into the compartment, it went up to 60 mR which we saw on our monitor. It stayed just about where it was. When we walked into the personnel air hatch, it was still the 60 mR/hr. So we had to negate all readings that we had.

(Question) - When you put the plastic bag on, how long did it last?

(Answer) - With the plastic bag it lasted the whole time we were in there.

(Discussion Leader) - I haven't heard anything then that would say that we can't continue with the way we are currently proceeding with the instruments that are available to us.

Let's go on to our last subject, the decontamination of this building. I think the place where dose rates are going to be the most severe problem to us is when we get down into the basement after the water is gone and begin to tackle

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the "Ring-Around-the-Collar" problem. This is where we could have beta fields that we have observed so far appear small by comparison. We are talking about very high fields, say in the thousands to tens of thousands of rads per hr beta. What do we need to measure this field?

(Question) - Will Krypton be a problem?

(Answer) - No, Krypton will be gone.

(Discussion Leader) - We may be picking up high alpha fields from the Cesium 144. It is going to be down there in the basement just like a sludge. Ruthenium 106 will also be present.

(Question) - What was the instrument that you mentioned, Sid?

(Answer) - TOL/E. This is the official Federal Republic of Germany survey instrument. It is a gas amplification instrument. It has about 8 decades or so with and without amplification. The TOL/E measures from background to 3,000 R/hr. It can be used with and without gas amplification, so it is a very low energy or low range instrument. The first range is around 0 to 3 mR/hr and that is used without amplification. It is a straight ion chamber instrument at that point.

(Question) - How big and bulky is that?

(Answer) - It's about the size of a small stereo speaker. It has a long set of cables that come with it and go back to a reader. I have only read the German literature on it.

(Question) - Did someone mention a Juno type of instrument, R02A?

(Answer) - Its range is 0-50 R/hr. The big problem with it is that it is handheld. To get any measurements you must get into the area. Also the window thickness does not meet dosimetry standards, so you have a problem in relating what your personnel dosimeter is going to give you, if you want to use such an instrument.

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(Comment) - I would prefer to use an instrument that has a small chamber. For these reasons you have less exchange with the atmosphere environment and it is easier to calibrate. Calibrating large volume chambers for betas is a difficult thing to do, and I would like to avoid it if at all possible.

(Comment) - The R07 is a smaller chamber. It is about an inch in diameter. I think the active range or the active depth of it is about 1-1/2 inches.

(Discussion Leader) - The R07 is a developmental instrument that Eberline has made for us. If at all possible, I would like to avoid research and development projects and work with something that someone else has de-bugged and is hardened, so that it can be used in a hostile environment.

(Question) - What is the purpose of the instrumentation that we are talking about?

(Answer) - To go in and assess what the dose fields would be before we put the people in to do any work.

(Discussion Leader) - In the sump you are going to have plate out, or "Ring-Around-the-Collar." Those fields are going to be high. If you have got any sort of dirt, you will actually concentrate that with some sort of a diatomaceous filter effect. There will be plate out on top of the sludge.

We have a gallery over in the auxiliary building where we tried to do measurements with TLD's because we didn't have any instruments to measure directly. The indications from the TLD measurements are in the range of 5 to 10 thousand R/hr beta.

(Comment) - Another possibility on a real high dose is a pressurized ion chamber like the Raydactor or the Jordan rad gun. These can be remotely operated by an extension rod or via cable. The efficiency on those, for beta, is rather low, but as long as we are aware of that, we don't care.

You can buy instruments up to 10,000 R/hr. You must take measurements and also expose TLD's at the same time to get a general idea of what the dose is.

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There is something called the CPTP; commercial units have been used. These can go up to 50,000 R/hr on 200 foot of cable.

(Question) - What kind of windows does it have?

(Answer) - It doesn't have any.

(Question) - So it is not good for betas?

(Answer) - You might be able to modify it.

(Question) - Is it an ion chamber?

(Answer) - Yes.

(Question) - Is it pressurized?

(Answer) - I don't know that.

(Discussion Leader) - When this whole workshop was put together, we were sitting with the technical work group. However, we have not worked with the people out in the weapons program. They have rapid fire recovery teams that go into exposed areas that have some tremendously high fields. I was hoping to get some of that experience here. They may have sophisticated dosimetry that might be available, possibly commercially. Or, for instance, Oak Ridge has the capability of designing their instrument to meet their problems. I was hoping to find out if there is somebody sitting in the laboratories with something that may fit our needs.

We have two or three different dosimetry problems. We are looking through small penetrations. We need to define what the people that are going to go in should wear for dosimetry and finally we have this "Ring-Around-the-Collar" that we are going to be faced with in the sump. I really haven't heard anything in the Workshop about some of the more sophisticated equipment that may be sitting around and not being used. If persons here know of any or know of somebody that might know of something, I sure would like to get that information.

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(Question) - Are you planning any more of these workshops?

(Answer) - This was called the Decontamination Dose Reduction Technology Workshop jointly sponsored by EPRI and DOE. Then it got confused because DOE thought that we had already sponsored another dose reduction seminar. Everybody up here at the Island had been up to their elbows in the work and didn't have a chance to go sending people everywhere to all these conferences. What we want to do is make contact for the people in the trenches at TMI at these workshops. It is not out of the question that the technical working group will be meeting again in December, and if it is feasible and desirable, we might try to get another workshop just on beta dosimetry problems. I hope that we didn't give the impression that we are jumping into the fire blindfolded.

(Question) - Your time frame is pretty short, isn't it?

(Answer) - The time frame is short. We felt that we could at least get some communication going with the people that are needed.

(Comment) - The people at the Nevada Test Site that are responsible for doing the health physics initial entry, called Reynolds Electric Electrical Engineering, have a lot of initial entry experience and/or provide the initial health physics surveys. They might be the individuals to check with. I was in on a lot of those last of the above ground test bomb shots, and the first few below ground tests at the NTS. We used a Victoreen chamber. It was actually a Nero white ion chamber with about 8 or 9 atmospheres of pressurized argon that was used with the most sophisticated readout that could be built at the time. The reason that it was used was because there was no problem in running a couple of thousand feet of line out to the instruments. These were used extensively through all of the early tests, and then during the later ones where they destroyed the entire core by throwing the rods out. They used those Nero white ion chambers exclusively. The problem is that you had close to 100 milligrams per square centimeter dimension gas chamber, and those were used exclusively for one test after another. I saw literally thousands of those over about a 10-year period out there. They weren't trying to measure betas. Dick Milligan is the guy to talk to who has been in charge of health physics for 15-18 years. He

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would be the person to talk to specifically on whether or not they have something more sophisticated.

(Comment) - Hughes Electronics is pulling a lot of the stuff together. The concept is still there but transferring that signal into dose information has gotten sophisticated. I will be curious as to whether Hughes has something. I wouldn't want to send anybody into a field that I didn't really know enough about. I wouldn't put my own self in it either. I don't think anybody would. If we have some equipment sitting in a laboratory, I think we can go and get it.

(Comment) - I think maybe you may not find all that much beta dosimetry around. Finding sources to test them with is also difficult. We didn't have the manpower to develop an instrument, but we worked with the EML Lab. One of the instruments they had is not necessarily high range, but that is principally because of the electronics that were put in it. It is basically two chambers, one 7 milligrams per square centimeter and the other, one thousand milligrams per square centimeter. It is sort of like dosimeters.

(Discussion Leader) - Our sources will not be terribly strong, but we will have six large area sources several inches in diameter. They will be made with six separate energies. We have three point sources in different energies. We have a large source that will give dose rates that are reasonably well known. We have an extrapolation chamber, and we have characterized the source as best we can at several distances. NBS has not been active in this area at all up until recently and they didn't want to provide a characterization.

(Question) - What kind of plans do you have?

(Answer) - They are flexible. For dosimetry purposes they are certainly adequate. You are really fooling yourself if you care whether it is more than 5% accurate. The instrument that was design modified will not work well for contact measurements because the ion chambers are large enough that it doesn't work. But they will work for everything else. If you decontaminate the surfaces, that might be a good place to start. If not, you can use the TLD techniques for the hot areas that you are decontaminating and get an in-place measurement.

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(Question) - If we can pick our instruments, can you calibrate for us?

(Answer) - Well, I don't know that we will be able to calibrate, but hopefully we will at least be able to do some characterization. The problem with the slab sources is that they are not real high, probably on the order of 100 mR/hr to 500 mR/hr. It is a problem of the license and how much they can handle. For example, they first started to buy some of the sources commercially. The Strontium 90 source rate we originally asked for would take more Strontium 90 than his license would allow him to have in his whole facility.

(Comment) - If anything comes as a surprise to me, it is the supporting laboratories throughout the Nation. They don't have a facility that does standards. What we are lacking in the United States is some sort of facility that could meet these purposes. We have talked to all kinds of people some years back and the National Physical Lab did attempt to make some sources and I talked to the individual involved.

(Comment) - Does that seem to be your experience at Oak Ridge? Do you guys have any facilities of that nature? I know you often pull things out of your pocket but it costs money. It may be that you don't have to calibrate for betas. You know the physical characteristics of your device; then you calibrate for gamma, and then you calculate or otherwise determine the beta. It doesn't have to be all that accurate. All that you want to do is to get a general idea of the dose an individual is going to get. No matter how good your instrument is, it won't tell you what the dose the person is going to receive. The personnel dosimetry will tell you what the dose is that he has received.

(Question) - What you do is characterize your instruments with the betas and from then on calibrate for the gammas, correct?

(Answer) - I agree with most of what was said, but I disagree when you characterize the instrument with gamma and then walk in the field. If the field changes, which it very likely will, the geometry problems and the energy problems are really enormous with beta. If you have any change because of filtration or plate out of different isotopes, you can get into really large errors rather quickly, unless the instruments are designed to measure the dose you are trying to measure. This is

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because of the relative extenuation of betas in window thicknesses of the detectors. It is very important to come as close as you can to have an instrument that could measure like the standards call for. We should try to talk about the standards in a few minutes.

(Question) - We went to seven milligrams per square centimeter. Do you have the depth of your sensitive volume very shallow so that is is not a significant absorber?

(Answer) - Yes.

(Comment) - Then why change? The instrument may be o.k. However, I think what we were finding out here is that there are very few instruments that are made that way. Physics Instruments is selling an instrument which may need a different electronics package in order to cover the higher range that they want to cover.

(Question) - I have a question that leads right into what you are talking about. Does anyone have a good program for theoretically determining the re-combination from electrons in ion chambers? Would you calibrate so far and after that say, "All right, theoretically this is what we think our instruments are going to do?" We know when we begin to get up in the high range we are going to have significant re-combination. If somebody has this upon a computer, I would like to get it and put it up on the GPU computer and use it for some of the work that we are doing. I hate to start from scratch and do a whole re-combination program from beta spectra if I can avoid it.

(Answer) - We have done some studies of certain detectors, but we don't have any computer models.

(Discussion Leader) - No matter how big your source is, it is unlikely that we are going to get one that is going to take us to where we must be. We know that we are in the area of 10,000 R/hr on some of the surfaces outside of containment in the auxiliary building. Inside the containment theoretically the surfaces are going to be very "hot."

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(Question) - Did you do any work on what you think the theoretical dose rate will be close to some of the surfaces, after the water is gone?

(Answer) - No, this has not been done yet. We calculated numbers on a beta plate out from a "Ring-Around-the-Collar." Assuming the theoretical spectrum, that calculation wasn't too far from what Oak Ridge has measured in the sump, which is in the 550-600 R/hr contact dose range.

(Question) - What did we get in the room?

(Answer) - We got 7,000 R/hr; there wasn't that much coolant volume. But that was an evaporated coolant.

(Question) - Is that what the "Ring-Around-the-Collar" is projected to be at contact?

(Answer) - You are talking about the first time you drain the sump. That factor must go up about 800 times. That would be almost 400,000.

(Discussion Leader) - Before we adjourn, it would be in line to say that a consensus determined that a special workshop is needed within about two months on the dosimetry. After the incident out here, one of my guys spent two days down at NBS trying to take everybody's instruments that had been used and make some sense out of it. Results were very poor. He came back shaking his head at me. He said, "Bob, if you are concerned about how we do dosimetry here, I want you to realize that we are not all that much worse than NBS." However, I think that as a result of this incident, NBS is becoming much more interested. If you had gone to them a year ago and asked them to calibrate a beta source, they wouldn't have been very interested. Now they are indeed putting some manpower on this. They have the extrapolation chamber and they are working on it. But their business is to get precise, because they are the standards laboratory. In the real world, you aren't concerned whether you get better than a 5% calibration factor. That is not their kind of thinking. The only thing that needed to be done, which has been done, is to get them to start thinking in terms of calibrating the source in such a way that you can do something better. I didn't mean to criticize the NBS, I was just saying, we haven't driven them

HIGH BETA FIELD DOSIMETRY WORKSHOP

to service us correctly. Their experience is different. You have to realize that from the laboratories to the trenches at a nuclear power plant, the degree of expertise drops off exponentially. It's the expert's responsibility to insure that there are sufficient standards.

It's important to know what ANS or ASTM have in their hands, representing the truth. Something should be set up, either through ANS or the HP Society, to show how you go about calibrating beta dosimetry instruments. This should also include the calculations and calibrations for those in the laboratories. In the past, the beta dose limits have not been so restrictive, so it has not been a problem. We know that when we use this conservative factor we will be o.k. We'll stay below the limits and you stay below the limits. In fact, the limits are so overly conservative, that the worker will never get over-exposed. Safety was really being obtained and that is one of the things that needs to be addressed. I think everybody should be aware of that over-conservatism and its non-applicability to beta considering all of the technical working group activity. There is a very strong likelihood that the standards may be reduced, not because there are good technical reasons for it, but because of political reasons. If that happens, then everybody is going to have beta dose problems. Whether it is something that you pull out of a reactor, an accelerator or a fusion machine, we will have problems because of activation or the like. The standards are overly conservative in two ways: they are conservative like all of our other standards are, but in addition, we found when we are starting to look through the literature in order to design a new beta dosimeter, we found there is absolutely no evidence that you can produce skin cancer ulceration with any dose, no matter how high, if you work only to the depths that we use as standards. So if you use 7 milligrams per square centimeter or go to 10, such as the new recommendations, then it doesn't make any difference if you put the individual in front of an electron accelerator. We are living with a problem of making the instruments and dosimeters fragile and causing other problems because we are trying to design to something that is unrealistic and gives an over amount of protection. We ought to all be pushing a little bit to make the standards maybe something like 5-50 milligrams instead of 5-10. That makes a big difference if you have any soft betas in there. Anybody that has worked in this area realizes that there is a beta spectrum, so you will always have soft betas. We should push for that.

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